Three basic considerations should guide the preparation of the 5-year program strategy.

- The Department should give high priority in the next five years to commercialization and technology development activities for those solar technologies which appear to be capable of providing delivered energy at a level competitive with alternative sources priced at their marginal costs.

- The Department's priorities for the rest of the solar technologies should be guided by the size of any additional premium (on a per barrel of oil equivalent basis) which would be necessary to bring each technology on line. Decisions about the pace of commercialization and additional R&D will be made on the basis of the estimated additional premium required and its justification; solar technologies should benefit from higher subsidies than an oil import reduction premium alone because of positive environmental and employment effects.

- As the Solar DPR and several other studies have indicated, the Department's R&D efforts in the solar area should concentrate more heavily on the development of near-term technologies for producing heat and fuels, community scale applications and low-cost solar applications rather than on technologies to produce electricity from large centralized facilities. The relative emphasis in the R&D program between the solar technologies should be guided by an understanding of the end use sectors which is being gained from the commercialization program and other sources. The basic research on advanced renewable energy systems which is crucial to achieving solar's long-term potential of contributing to the Nation's energy supply is discussed in Section G.

V. SOLAR PROGRAMS

The DPR recommendations and the planning principles provide the general guidance for solar systems planning. The specific choices of activities related to each technology must be based on a number of factors including technical readiness, economic competitiveness, environmental acceptability, and manufacturing capacity. The program office should develop interim goals for 1985 and 1990 for each technology based on end use requirements and the probable cost of delivered energy for each applica-

($63.0 million). The FY82 budget should continue this trend.

To promote the use of gasohol, the Department will establish an Office of Alcohol Fuels under the AS/CSE. The Department has set a "target" of producing at the rate of 10 percent of all unleaded gasoline blende with 10 percent ethanol during 1981, and 30 percent of all unleaded gasoline blended with 10 percent ethanol by the mid 1980s.

While the potential contribution of biomass is believed to be large, there is currently too little information on costs, environmental implications, effect on food production, etc. upon which to base further long run program tradeoff decisions. The analytical and experimental work necessary to provide this information is important and should provide results in the mid term if the full potential of deriving high quality fuels from biomass is to be realized.

B. HYDROELECTRIC

Hydropower is already the most fully developed renewable energy resour Approximately 3 quads per year are now produced at primarily large-sca high-head facilities. The DPR projected that an increase of .5 to 1 quad of high-head (mostly large-scale) production is possible. While small hydro projects produce a negligible amount of power at the present time, the DPR set a target of .8 quads by the year 2000 from predominantly low-head facilities. Studies underway since the DPR suggest that these estimates could be low.

DOE's current hydropower efforts relate exclusively to small-scale projects. The long-range goal is to establish a small-scale hydroelec industry based on the rehabilitation and retrofitting of existing dams and the development of new projects.

The emphasis of the program is presently on feasibility studies. Priority should be given to activities aimed at making small-scale hydro projects a desirable private investment. In particular, this means more effort in reducing institutional barriers to obtaining permits and licenses.

Overcoming utility reluctance to purchase excess power is important. Frequently, such a market is essential to economic feasibility for small projects. Examination of financial incentives, such as tax cred s for small-scale operations, is also necessar .

MEMORANDUM FOR: Under Secretary
Chief Financial Officer
Assistant Secretaries
General Counsel
Assistants to the Secretary
Administrators
Directors
Inspector General

FROM: Charles W. Duncan, Jr.

SUBJECT: Revised Draft Policy, Programming,
Fiscal Guidance, FY 1982-86

I am issuing the attached Policy, Programming, and
Guidance to provide direction for the work of the D
during 1980 and in particular for the preparation o
five-year programs due March 7. I have reviewed yo
comments on an earlier draft of this document, and
ciate the time and effort you put into them. Based
comments, the document has been revised in a number
places.

I plan on maintaining this document in draft status
policies and programs may change throughout the yea

Attachment

CWDunca

CONTENTS

I. OVERVIEW

A. SCOPE AND PURPOSE OF THIS PAPER

This paper encompasses the rationale and guide for major DOE energy policies and programs in FY 1982-86.

The purpose of the overview is to present both an analytical perspective on the energy problem and a framework within which government programs designed to address various attributes of that problem may be evaluated. Its development is intended to focus discussion and debate about energy policy within DOE and possibly other parts of the Executive branch.

Three topics are discussed:

- The nature of the energy problem
- The role of government
- How much government activity is justified.

The last quarter of this century should be viewed as a period of adjustment to more expensive and less secure supplies of imported oil. The principal role of the government in the energy area is to foster this transition. This role and the appropriate level of government activity in the energy field must be viewed in the context of a rationale for governmental intervention into economic matters. In general, consumption, production, development, and marketing decisions should be left to the private sector unless there are external factors or market imperfections such as the national security issue of excessive dependence on foreign oil. Such factors prevent the private market from acquiring adequate energy supplies, allocating them efficiently, and providing for national security. The broad goal of government activity in the energy area is to make the nation better off than it would be if private markets were left to themselves by ensuring that these objectives are met. Any government action which increases the efficiency of markets serves this purpose, in energy as in other sectors of the economy. In addition there are four classes of activity in which governmental intervention in energy markets can be justified

tainty associated with alternative sources of energy and conservation.

-Increased and diversified foreign supplies.

These categories are used to present and evaluate policies and programs in the sections for each of the energy areas. Each of these categories applies equally to conservation (energy efficiency) and energy production. This evaluation is made in light of other government objectives in areas closely related to energy. Those areas are equity, competition, and environment. The principal criterion for government action is whether the nation can obtain greater benefits if the government takes one action rather than another or no action at all.

B. NATURE OF THE ENERGY PROBLEM

The energy problem is both international and domestic in nature. For the next two to three decades, the source of the energy problem will be the fact that a large amount of low-cost oil is under the control of a few producing countries in the Middle East. The tremendous power these OPEC countries hold over the oil market and the political instability endemic to the Persian Gulf region make energy a major concern for the U.S. and its allies. The international nature of the energy problem can be divided into three components:

-Wealth transfers to oil producing states as a result of high and increasing oil prices caused by OPEC market power

-Vulnerability to supply disruptions, including embargoes, that manifest themselves in sudden and large increases in oil prices

-Uncertainty about the long-run price and availability of oil from the Persian Gulf.

Each of these components of the energy problem stem in part from the inability of the energy market to adjust quickly to changing circumstances. Both energy supply and demand are relatively capital intensive. Much of the existing capital stock has a long lifetime, and new investments have long lead times. The

Industrial nations have historically been concerned with the sources of their raw materials and particularly of their energy supplies. Throughout the nineteenth century, nations obtained the energy needed for economic growth (primarily coal and hydro-power) almost entirely from domestic resources. A new industrial era began with the automobile and the airplane--an era based on oil consumption. Industrial nations quickly recognized that control of this new fuel source was essential to their security and prosperity.

The necessity for industrial powers to maintain access to oil resources has been continuous. However, in the 1950's and early 1960's, oil was generally discovered, developed, and brought to market more rapidly than demand grew. Moreover, a sufficient portio of the world's oil resources was under western control which ensurec that ample quantities of oil would be delivered to the industrial nations at low prices.

Oil abundance and western influence were closely related. Western influence over the producing nations permitted the process of explor ation and development to operate with a high degree of success on a principally commercial basis, unfettered by political risk. Large untapped or shut-in reserves created a cushion of spare capac which could be tapped during any interruption. Free world spare capacity stood at 24 percent of free world demand in 1955 and 33 percent in 1960. This substantial amount of spare capacity, togethe with direct control of key producing areas, ensured that the world c supply system would be operated in a manner which benefitted the western powers.

The industrialized world began to lose control of energy sources in 1959 when the U.S. imposed a mandatory oil import quota. Demands for the imposition of the quota were triggered by the entry into the U.S. of cheap oil from the Persian Gulf. Domestic producers argued that national security would be jeopardized if the U.S. came to rely on foreign oil. They warned that the U.S. would not be self-sufficient in oil if domestic oil producers went out of business. As an alternative strategy, some suggested creating an adequate reserve to protect the U.S. against short-term disruptions while relying on cheap imported crude for day-to-day supplies and leaving domestic oil in the ground until the world market price warranted its production. This course of action was not followed.

First, by placing an economic premium on the development of higher cost U.S. oil resources, it drained U.S. oil fields at a far faster rate than would have occurred in a free market. Second, by cutting off the U.S. market from increasing supplies of foreign crude, the quota cut world demand from previously projected levels, reduced the revenues of the producer nations, and stimulated the formation of OPEC.

Another blow to the security of western oil supply came from the shrinkage of western control over less developed regions. As late as 1960, four of the 13 current OPEC members were British colonies or dependencies. Two more were French colonies. British troops were stationed in the Persian Gulf and Libya, and controlled the straits of Malacca, Hormuz, Aden, and Gibraltar. Twelve years later, only Gibraltar remained. At the same time, the legal doctrines of "act of state" and "changed circumstances" undercut much of the protection which had previously been afforded the overseas investments of western companies. The producing nations developed sophisticated managers who understood the international oil business as well as their counterparts in the west. A new spirit of nationalism swept many countries. Behind all these changes lay the shrinkage of western influence in the developing world.

By the early 1970's, the oil-consuming world was on a disaster course:

- Investment in exploration and development in foreign countries had fallen as fewer companies were willing to assume both the geological risks of dry holes and the political risks associated with doing business outside western legal structures. Spare capacity even in the Persian Gulf had dwindled. Several of the major producing countries unilaterally imposed political ceilings on their production at levels substantially below their technical capacity.

- The depletion of U.S. reserves had been artificially accelerated by the high domestic production levels encouraged by the import quota.

- Western influence in the major producing areas was at an all-time low.

- Demand for OPEC oil continued to grow at a rapid pace, fueled by

production. Oil suddenly became scarce in world markets. Spot purchases of oil for extremely high prices were seen by producers as reflecting the "true, long-run" price of oil, and they began to price accordingly. The course long advocated by "radical nationalists" in the producing countries had been followed and had gained credibility from its success. Suddenly, oil was priced, and capacity installation decisions were made, in ways which reflected the interests of those nations which had oil to export, not the interests of the international oil companies and their home governments.

2. Current Context

In the beginning, some observers expected that normal economic forces would cause the cartel to crack and pre-1973 price levels to be restored. Since then, however, changes have occurred in the international oil market which preclude return to old levels of price and production growth.

- Decisions on these subjects are now made by governments which are the owners of the oil in place rather than by the international companies. To the companies, the long-run availability of oil was unimportant because they had no guarantee of being able to retain their concessions for a longer period. Since governments have a longer time horizon, they place a higher value on keeping the oil as a long-run investment than the companies do, and price accordingly. The rate of extraction before this change may have been too fast even from the view point of the industrial nations.

- Rising real oil prices and low real rates of return on investments obtainable in the international financial market have frequently made crude oil left in the ground more valuable to its owners than money gained from its sale. The resulting curtailment in oil field investment plans by a number of major producers serves to ensure that prices will continue their long-term rise.

- The producing countries are exempt from any antitrust law. OPEC provides both a mechanism which may be used for coordinating production and pricing policy, and a forum for sharing information and building mutual trust

The uneven distribution of world oil supplies limits the extent to which the oil market can be competitive even in the absence of international cooperation among producers. In addition, the character of the world oil market will probably result in further reductions in the extent of excess capacity available and thereby increase the vulnerability of the world oil market to curtailments in production.

3. Other Government Objectives

The Department of Energy is also concerned with other government objectives, including equity, fostering competition, and protecting the environment. Although the Department does not have primary responsibility for the development of policy in these areas, it is an active participant. The Department's plans and proposals should, of course, be developed in light of policy goals in these areas and contain thorough evaluations of the relationships, between its proposals and equity, competition, and environmental policy.

Adjustment to changing prices in the world oil market is often affected by the government's acting to promote these other domestic goals. These goals and the resulting government actions are often (and should be) a major influence on energy policy. A balancing process between energy and other national concerns is needed. Domestically, concerns for equity and the environment have led to a substantial body of regulations that affect energy market adjustments. Equity concerns have led to oil, gas, and electricity price regulations that have tended to encourage oil imports. The equity goal has also led to the proposed Windfall Profits Tax and subsidies for conservation investments targeted on lower income households. Environmental and safety concerns have led to regulations that have limited energy production and consumption of some fuels such as coal. Federal budget constraints and anti-inflation concerns often limit the scope of government activity. These concerns must be balanced against improvements in the operation of domestic energy markets. In a similar way, political concerns hinder oil production in many nations. Internationally, oil exploration and development is hindered in many nations because governments are unwilling or unable to give the necessary guarantees to the oil companies for the protection of investments and have not undertaken exploration and development themselves for a number of reasons.

of electric and gas distribution and transportation companies
to prevent abuse of their monopoly power. In 1954, the Supreme Court extended Federal natural gas regulations to the wellhead. More recently, statutory oil price controls were established in response to OPEC price increases after the 1974 embargo.

The basic principle of efficiency in energy and other markets is that customers and producers should face the marginal cost of energ Pricing in this way creates desirable incentives to conserve and produce additional domestic energy. Equity concerns for low-income families and others should be dealt with by separate programs such subsidized conservation loans or other special assistance programs help lower-income households cope with the higher costs of energy. Unfortunately, in the past, implementation of regulations to meet equity concerns has imposed additional economic costs on the nation creating price signals that encouraged consumption, discouraged production, and slowed the adjustment to higher oil prices.

The combination of oil price controls and the entitlements system, together intended to equalize crude oil costs to domestic refiners, subsidizes consumption of foreign oil in an attempt to prevent a transfer of wealth from domestic consumers to domestic producers. Deregulation will provide a substantial improvement as domestic prices rise to the world oil price. Equity concerns should be dealt with by substantial taxes on old oil production and consumer grants that are not tied directly to the level of oil consumption.

The gas market remains heavily regulated, at least until 1985. Consumption is encouraged and production discouraged because the Natural Gas Policy Act did not allow for the very high prices for oil for which natural gas is usually a direct substitute. As a result, adjustment in the gas market to high oil prices has been delayed.

Rate regulation in the electric utility industry holds prices substantially below the cost of generation from increasingly expensive new plants. Moreover, this same regulation at the state level has severely constrained the ability and willingness of utilities to finance new generating plants even though new coal and nuclear plants can lead to substantial cost reductions and oil import savings compared to the oil plants they would replace.

Dependence on the price mechanism to achieve efficiency within th

trust legislation have been the principle government response to this latter concern. The Department is committed to analyzing the structure and performance of the energy industry in order to identify any significant factors which may impede the free and competitive operation of the market. Moreover, the Department is also committed to ensuring that its own programs do not adversely affect the competitive structure of the energy industry.

<u>The Environment</u> is a major policy issue because preventing environmental degradation and developing energy are both national objectives. Some fuels and many technologies threaten to degrade the environment and the environmental problems related to energy production and use must be identified and resolved promptly. Coal, nuclear, shale-oil, and synfuels create more serious environmental problems than conventional oil and gas. Yet these energy sources will become increasingly economic and desirable as world oil prices increase. Therefore, achieving a balance between efficient energy production and protecting the environment is likely to become increasingly difficult over time.

While energy and environmental objectives are often mutually reinforcing, especially in the conservation area where using less energy to achieve the same economic output enhances the environment, in the production and supply area energy and environmental concerns can be made compatible by reaching a sensible balance. Such balancing places additional strains on the institutions charged with achieving our energy and environmental objectives. The danger is that our institutions will fail to address this balancing problem directly and will thereby create delays and uncertainty. Avoiding this danger will require close and continuing coordination among the national, regional, state, and local levels of government. The process is going to become more difficult in relation to air and water pollution as the nation begins to rely more heavily on coal and eventually on synthetics.

The creation of the Energy Mobilization Board is intended to deal with the potential delay problem on a case-by-case basis for important projects. However, the problem is widespread and requires resolution of fundamental questions such as the regulation of air pollution or the use of scarce water in the West.

<u>Foreign governments</u> constrain the amount of oil exploration, development and prod ction in many nations.

countries.

C. ROLE OF GOVERNMENT

A role for government is justified when actions based on private incentives alone cannot obtain all the benefits potentially available to the nation. Governmental intervention in the energy area is justified because the U.S., as a large buyer of imported oil, can affect the market. The private sector has no means to act collectively to realize U.S. market power, but the government can promote collective action that exploits this market power.

The justification for government action is substantially greater if the U.S. and its allies act collectively than if the U.S. acts alone. Collective action is desirable because consuming nations acting together can have a much greater impact on the world oil market than can have each nation acting alone. Therefore, substantially greater steps by the U.S. are justified if they result in similar actions by other nations. Coordination among nations to capture greater benefits than each can capture alone is based on the same rationale that justifies action by the U.S. government for the nation as a whole. However, coordinated action is much more difficult among a diverse group of nations.

The four principal roles for government in the energy area are to encourage or undertake:

- Short-run contingency plans

- Oil import reductions

- R&D and related activites that reduce lead times and the uncertainty associated with alternative sources of energy and conservation.

- Increased and diversified foreign supplies.

Each of these roles relates to one or more of the three elements of the energy problem: high and increasing oil prices, vulnerability to supply disruptions, and uncertainty about future prices. Even though many of the specific policies discussed in later sections are about different fuels, the rationale for almost all of them

with a disruption.

There are two rationales for government contingency planning. Each rationale is based on the premise that there are benefits available to the nation that the private sector has no incentive to capture. First, credible contingency plans may provide some measure of deterrence to those who would disrupt oil supplies for political or military purposes. This deterrence rationale is analogous to that for national defense because the benefits of deterrence accrue to the nation as a whole.

The second rationale for contingency planning is similar to that for import reduction during normal periods. Offsetting the reduction from the disruption with oil in storge would negate the large price increase that otherwise would accompany the disruption. The benefits of lower oil prices accrue to all importers, not just those who have reduced imports. Therefore, some collective action through import-reducing contingency plans is desirable. More generall collective contingency plans among all consuming countries are even more desirable.

The first step in contingency planning should be to ensure that the market place works as freely as possible. Anticipation of allocations of supplies away from those who have stockpiled and imposition of price controls discourage desirable private sector actions such as stockpiling. The allocation program during the 1973-74 embargo gave less oil to those who had stockpiled than it did to those who had not. Such an action gives a clear signal to the market place that the government will penalize those who attempt to protect themselves from disruption.

The second step in contingency planning is to develop standby mechanisms for increasing domestic supplies and reducing consumption. A large Strategic Petroleum Reserve (SPR) is the lowest-cost means of increasing supply during a disruption. Standby surge capacity in producing fields is generally a more expensive means of increasing production on short notice because drawdown rates in the field are technically limited and, for this reason, require many dedicated facilities and the corresponding deferral of valuable production. Large amounts of oil must be stored, in effect, to obtain standby capacity. SPR should be filled rapidly to substantially reduce our vulnerability.

petroleum product excise taxes that can be activated to reduce demand during a disruption.

Any reduction in U.S. imports during a disruption as well as during normal periods benefits other consuming nations as well as the U.S. through lower prices. For example, releases from the SPR replace some of a worldwide shortfall and depress prices as a result. Only about one third of SPR releases replace U.S. imports. Much of the benefit of SPR release is realized in the form of a lower price for our remaining imports. Similarly, the U.S. benefits from stockpile releases and demand reduction by other countries during an embargo.

2. Oil Import Reductions

Oil import reductions put downward pressure on oil prices and reduce our vulnerability to interruptions to some extent. The benefit of a lower price path and a smaller chance or cost of disruption accrues to all importers of oil, not just those who reduced oil imports. Therefore, no individual importer has an incentive to take into account the benefit to the nation as a whole from reducing imports. The role of government is to create incentives to reduce imports that reflect this benefit to the nation.

An oil import reduction can lead to a combination of benefits that range from benefits derived almost entirely from a price reduction to those from a reduced vulnerability. The nature of the benefit depends on the response of OPEC to a reduction in imports. At one extreme, th OPEC production path may remain unchanged, with a lower price path the result. In this case, our vulnerability to import reductions is reduced only slightly because the same amount of oil continues to be produced by insecure sources and because world oil consumption will remain substantially unchanged. Because total production and consumption do not change in this case, the size of the price increase during a disruption is no different from the size if the U.S. had not reduced imports. Thus, the cost of an interruption is reduced only because we have somewhat fewer imports that are subject to a price increase durin an interruption.

At the other extreme, a reduction in imports may be fully offset by a reduction in OPEC production. There is no benefit of a lower price path in this case. However, there is a reduced threat of interruption t e at OPEC oroduction cuts have occurred in insecure

The lowest-cost means of reducing imports are conservation (energy efficiency) and alternative sources of energy that are economic at world oil prices. Import reductions of this kind are costless in the sense that the private sector would find them economic if they faced world oil prices and no government actions were taken to obtain energy benefits. These import reductions could be obtained by adopting actions guided by two principles: deregulate markets where competition exists and use market-like mechanisms when regulation is necessary. Deregulation of the oil market is a highly desirable first step in this direction. However, under current law deregulation in the gas market is not scheduled until 1985. Producers and consumers are faced with a gas price substantially below the marginal value of gas which is a direct oil substitute. Gas production, conservation, and decentralized energy supplies such as solar are discouraged as a result. Rate reform in the form of higher rates for marginal consumption or other means is called for to give consumers the signal that oil and oil substitutes have substantially increased in cost.

In the electric sector, current rate-making practices have many of the same failings as those in the gas industry and discourage reductions in oil use as well. Relatively low rate increases have hurt the financial condition of the electric utilities to such an extent that they are unable or unwilling to construct new coal and nuclear plants to replace existing oil and gas plants. This financial problem is a serious national concern because the construction of new coal plants is one of the largest and lowest-cost alternatives available to reduce imports. The nation would gain from lower-cost electricity even if oil prices do not continue to increase and if there were no national benefits from reducing imports.

The nation can obtain additional benefits by encouraging conservation and production to a greater extent than would occur under deregulation alone. The simplest mechanism to achieve these benefits would be a fee on imported oil that reflects the benefit of additional import reduction. A fee on oil imports would have the advantage of allowing the market place to determine the least-cost means of reducing imports. An excise tax on products would have much the same effect as a fee but would not encourage domestic oil production. An import fee would result in a transfer of wealth from domestic consumers to the government and domestic producers. An excise tax, which must be higher in order to have the same impact on oil imports,

The tremendous amount of uncertainty about future oil prices compli-cates decisionmaking in the energy area. Planning is particularly difficult because of the long lead times associated with developing, siting, and constructing many energy-producing and energy-using technologies.

There are three kinds of governmental activities that are appropriat for dealing with this uncertainty:

- Purchasing or producing and disseminating information through R&D, exploration, improved forecasting, marketing and public information programs to stimulate the market place to adopt energy efficient technologies and practices.

- Undertaking investments or changing regulations to lower the co of adjusting to higher world oil prices by reducing lead times

- Establishing stable, long-run government plans for energy and environmental policies or regulations and incentives, and thereby reduce uncertainty over future government policies.

It is difficult for any firm to capture all the benefits of R&D. The patent system provides some protection, but other firms can use the new ideas, hire people that have developed specialized knowledge, and capture some of the benefits for themselves. This process may lead to under-investment in R&D because firms do not capture all the benefits that accrue to the nation. The problem may be more serious in energy than in other sectors of the economy because there are additional benefits to the nation from R&D that wi eventually lead to reductions in imports in the future. Firms will not take these additional benefits into account when making R&D investment decisions unless the government makes credible guarantees of subsidies above the world oil price for import reductions in the future. In a similar manner, firms may not have sufficient incentiv to develop low-pollution technologies that may have a high payoff to the nation as pollution becomes an increasingly serious problem.

A government role in resource identification, and supply-and-demand forecasting is justified since these types of information can be use to evaluate the costs and benefits of various options. This informa-tion thus provides a basis for planning in both the public and priva sectors. For example, uranium supply forecasts and electricity

Where the government has access to better information than private parties or where individual purchasers have inadequate incentives for scanning the market, there is a legitimate role for the government in disseminating information. For example, the average homeowner has little ability to determine the energy efficiency of appliances or the relative value of different types of insulation in the absence of effective labeling standards.

The economy incurs substantial losses because of the slow rate at which it can adjust to uncertain and changing world oil prices. Some types of investment activities in R&D can reduce these lead times at relatively low cost. In the general expectation of high energy prices, firms in the private sector will undertake R&D investment to reduce lead time. The government also can have a major role in increasing the rate of adjustment because it is a major cause of long lead times. The regulatory process can cause substantial delays from the time a decision is made to initiate a project until its final completion. However, many steps can be taken to clear projects through the regulatory process well in advance of the time when they are likely to become economic. Then, if oil prices rise sufficiently to make the projects economic, construction can start without delay. This approach may be most appropriate for synfuels and other technologies that are not yet economic. Private-sector planning and investment activity will also be affected by uncertainty about long-run government policies on incentives for energy production and on regulatory activities. By providing stable, long-run plans and by announcing these policies to the private sector, the government can substantially reduce the uncertainty surrounding private-sector investments.

4. Increased and Diversified Foreign Supplies

Any increase in foreign oil production will put downward pressure on world oil prices. It will also decrease the threat of disruption if the supplies replace a less secure source. For these reasons, marginal production from most countries in the world is more valuable than production from the least secure sources.

Unfortunately, many countries are apparently not undertaking exploration and development that could lead to production that is economic at current oil prices. A major effort by the U.S. through the World Bank or other mechanisms to stimulate world production seems desirable. Loans for exploration and development are one possible tep t at

supply disruption by encouraging increased natural gas production in foreign countries. This potential will be greatest if the new source of supply are not already major producing states and if they are located in politically and militarily secure regions. The government should take action when it is difficult for private-sector firms and potential producing states to reach an agreement.

D. HOW MUCH GOVERNMENT ACTIVITY IS JUSTIFIED

The principal criterion for judging how much government activity is justified in energy is whether the benefits of a particular action exceed the costs and whether the action can be done in the private sector with equal costs and time. This principle is often very difficult to apply in practice. However, there are a number of basic rules that have been used to develop options suggested in this Policy, Programming, and Fiscal Guidance paper.

The first rule is that the lowest-cost options should be exhausted first. In practice, this rule leads to deregulation and market-like mechanisms to promote conservation and production. Taxes, subsidies, and regulatory programs should be contemplated only after the least-cost benefits have been obtained from pricing energy at its marginal cost. If taxes, subsidies, and regulatory programs are considered, then one source of energy benefits should not be encouraged to a greater extent than another source.

The second rule is that a single measure of the benefits of reducing imports should be applied consistently over all programs. The oil import premium is a measure of the benefit, over and above the world oil price, of reducing oil imports. The benefits accrue from downward pressure on world oil prices and a reduction in our vulnerability to disruptions. The price reduction component of the premium is, essentially, the total savings on remaining imports because of a lower world oil price divided by the amount of import reduction. Analysis of an appropriate value for or bounds on the premium is currently being conducted. Over the next few months, the Department should settle on an appropriate range to be used for planning purposes.

A fee in the amount of the premium is the most straightforward way of signaling the market place that imported oil costs more to the economy than the per-barrel price. However, the same standard should be applied to all tax, subsidy, and regulatory programs if an import fee

addition to the premium. Conservation and natural gas production are good examples. On the other hand, technologies such as coal boilers and synfuels plants should receive a downward adjustment because they cause more pollution than does imported oil.

The third rule is that any programs that reduce our vulnerability should be directly compared with the costs of other options for achieving the same objective including the SPR and import reduction.

The fourth rule is that policies intended to affect foreign oil and gas supplies should be evaluated on the basis of their marginal contribution to the world oil supplies. It is of little value to provide subsidies or loans to producing states unless these expenditures result in an increased rate of production. Any additional production will provide benefits to the U.S regardless of its source; the size of these benefits on a per-barrel basis is roughly comparable to the premium on import reductions although this value will vary depending on the source of production. This value will be higher if the source of supply is politically stable and militarily secure. It will also increase if the producing country is not a major oil producer since it is in the interest of the U.S. for oil and gas production to be in the hands of a large number of relatively small producers.

The rules for determining how far to go in reducing or planning for uncertainty are more complex, but the general emphasis remains on providing consistent policies that improve the functioning of the market and deal with those particular problems for which private-sector incentives are inadequate.

CONTINGENCY PLANNING

I. GOAL

The Department's goal for the contingency planning program is described in detail in the overview. Simply stated, the goal is to minimize the costs to the U.S. of future disruptions in the world oil market.

II. PROGRAM

By far the most effective program for reducing the cost of oil market disruptions is the creation and operation of a strategic petroleum reserve for the nation.

The Energy Policy and Conservation Act of 1975 authorized the creation of a Strategic Petroleum Reserve (SPR) of up to one billion barrels of petroleum. However, current budget authority for the SPR is only enough to construct a total storage capacity of 450 million barrels and acquire a total reserve of about 220 million barrels, given current world oil prices. Approximately 230 million barrels of storage capacity is now ready to hold oil. This capacity is spread among five sites in Louisiana and Texas. These five sites can eventually be expanded to provide a total capacity of 538 million barrels.

The storage sites are easily accessible from ports on the U.S. Gulf Coast. At the present, a fill rate in excess of 600 thousand barrels per day is technically feasible. The U.S. currently holds terminal contracts which limit its maximum fill rate to about 600 thousand barrels per day. Over an extended period, the maximum fill rate would decline as individual sites became full. The current maximum drawdown rate from the three sites that contain oil is about 1 million barrels per day.

The SPR now holds 91.8 million barrels of crude oil. All of this was obtained from foreign producers and much of it was purchased on the spot market when spot prices were below contract prices (before the Iranian Revolution). SPR purchases ceased in March 1979 due to tight world oil supply conditions caused by the reduction in oil exports from Iran. The last purchases of SPR crude oil were delivered in August, 1979. No oil is now bein purchased or delivered

crude oil in caverns, and Japan has 33 million barrels of oil stored in idle tankers. In the private sector, West Germany holds approximately 100 million barrels of oil above and beyond normal inventory. The figure for Japan's private sector is about 250 million barrels above normal inventory.

III. ANALYSIS

Analysis of the Strategic Petroleum Reserve (SPR) supports three broad policy conclusions. First, under a wide range of assumptions about future U.S. and world oil markets, an active SPR program will substantially reduce the expected losses to the U.S. of future disruptions in the world oil market. Second, an active SPR program in which the stockpile is built up rapidly and in which there is a willingness to use the SPR in both minor and major disruptions yields greater benefits than a static reserve which holds a stable supply for use only during a major supply crisis. Third, since the operation of the international oil market spreads the benefits of the U.S. SPR to all oil importing countries, there are large net benefits to the U.S. and others from coordinating the petroleum reserve programs of all major oil importing countries.

A. THE ECONOMIC BENEFITS OF AN SPR PROGRAM

Conservation and alternative sources of energy can clearly reduce our dependence on foreign oil, thereby lowering the losses to the U.S. resulting from disruptions in world oil supplies. However, as long as we continue to import significant quantities of oil, an SPR is the best means of mitigating the losses attributable to supply disruptions. When released to consumers, the oil from the SPR will exert downward pressure on world oil prices. The magnitude of this downward pressure depends on the amount of oil released, which in turn depends on the quantity of crude oil in the SPR at the time of the disruption, the severity of the disruption, and expectations about the likelihood of future disruptions. Since disruptions in the world oil market exert upward pressure on oil prices and thereby impose large economic losses on the U.S. economy, SPR releases during disruptions can provide large economic benefits to the U.S. Of course, the SPR program also incurs costs. These are the cost of building oil storage facilities, the capital (opportunity) cost of holding oil between periods of disruption, and the world oil price increases (if any) attribu[illegible] the

and released at the correct times and at the correct rates.

B. ACQUISITION AND DRAWDOWN STRATEGIES

The rate at which oil should be acquired for or released from the SPR at any given time depends on a number of factors. These factors are the current condition of the world oil market and expectations about the future of the market - including the expected frequency, depth, and duration of interruptions; the likelihood of future slack markets during which SPR oil could be acquired without raising world oil prices; the expected level and price elasticity of future U.S. demand for petroleum; and the expected effectiveness of Administration programs designed to reduce oil imports.

For the purposes of analysis, four possible oil market conditions or "states" were modeled. The first was a slack market during which SPR acquisitions as large as 5% of OPEC production would have no effect on world oil prices. In contrast, the second market state modeled was a tight market during which any SPR acquisitions above and beyond normal oil consumption would raise world oil prices at a rate of $1.50/B for each 100 MB/D purchased. The third and fourth market states were minor and major disruptions. A minor disruption was defined as a 10% cutback in OPEC production (2.87 MMB/D in 1980). A major disruption was modeled as a 25% loss of OPEC production (7.18 MMB/D in 1980).

Using the market state descriptons, optimal acquisition and drawdown strategies were developed over a wide range of assumptions about the likelihood and duration of each of the market states. Assumptions about the level and elasticity of future U.S. demand for imports and the effectiveness of Administration oil reduction initiatives were also varied.

PE analysis indicates that the SPR acquisition and drawdown strategy which minimizes the costs of disruptions to the U.S. is a strategy of active participation in the oil market. The current SPR program of sporadic acquisitions aimed at the long term accumulation of a modest stockpile is <u>not</u> a strategy that

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1/ The analytic conclusions presented in this section are based on a draft staff analysis, An Analysis of Ac uisition and Drawdown

and very rapid drawdown during both minor and major disruptions. In many cases the optimal strategy requires that acquisitions continue even when the international oil market becomes tight.

One example of an optimal acquisition/drawdown strategy was calculated assuming that over the next 25 years the world oil market will on average be slack 40% of the time, tight 35% of the time, experience a minor disruption 20% of the time, and experience a major disruption 5% of the time. In this example, the optimal strategy dictates that during slack periods SPR acquisitions should continue at the maximum fill rate until the stockpile reaches 1.0 to 4.4 billion barrels.3/ If the oil market is tight, the acquisition of oil for the SPR will raise the price of all oil imports. Yet in many cases, acquisitions for the SPR should continue even in a tight market until the stockpile reaches 1.0 billion barrels. Only if the U.S. demand for imported oil is expected to decline substantially over the next decade and Administration initiatives to make import demand more price elastic are successful should SPR acquisitions in a tight market be discontinued regardless of the amount of oil already in the reserve.

During a disruption, even a minor one, maximization of the economic benefits of the SPR requires a quick response and rapid drawdown of the reserve. Given the assumptions as described above, it is desirable to draw down 600-800 million barrels of a 1.0 billion reserve during the first year af a minor disruption. This annual drawdown corresponds to a rate of 1.6-2.2 million barrels per day. During a major disruption, the optimal rate rises to 2.7 million barrels per day and the entire 1 billion barrel reserve is emptied in the first year.

3/ The range is the result of different assumptions about the level and price elasticity of future U.S. demand for imports. The maximum fill rate used in this analysis was a constant 550 MB/D. This number, rather than the current technically feasibl rate of 900 MB/D, was chosen to take account of current contrac limitations, unforeseen technical difficulties, and the natural decline in maximum fill rate that occurs as individual sites become full.

C. THE ECONOMIC BENEFITS OF INTERNATIONAL COORDINATION

Unless constraints are imposed it is unlikely under many possible supply disruptions that any one oil importing country will be able to keep for itself all the economic benefits of its own petroleum reserve drawdown.4/ The operation of international oil markets ten to equalize crude oil prices throughout the world, even during a disruption. For this reason, SPR drawdowns exert downward pressure on oil prices throughout the world, not just those of the country depleting its stockpile. In addition, to the degree that the existence of reserves deters certain disruptions, one country's reserves will once again benefit all importers. Since oil importin countries are not able to capture all the benefits of their own reserves and since they benefit directly from the drawdown of foreign reserves, there are considerably larger net economic benefits to be gained by all oil importers if they coordinate their reserve activities.

Specifically, a program which encourages International Energy Agency (IEA) members to act as a single entity will generate large net benefits for all members, including the U.S. Under the assumptions stated earlier about the likelihood and severity of future disruptions in the world oil market, slack market acquisitions for the IEA stockpile should continue until the reserve reaches 10 billion barrels. This is 2.5 times as large as the slack market plateau size for the U.S. acting alone (4.4 billion barrels). Under an optimal acquisition and drawdown

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4/ This conclusion does not apply under the conditions of the IEA sharing agreements, which allocate to each country its proportional share of imports during a disruption. Since the IEA agreements allow a country to use its own stockpile without lowering its allocation of imported oil during a disruption, each country would keep for itself all the benefits of its stockpile. However, the IEA agreements would not be triggered

... the U.S. currently accounts for about 30% of IEA oil imports, its share of the IEA reserves and benefits would be 30%. If feasible, coordination with the IEA would allow the U.S. to reduce its average reserve size by 30% while simultaneously increasing the net economic benefits it receives from the reserve by 100%. One important caveat needs to be added -- previous experience indicates that coordination among IEA member countries is difficult and the expected increase in economic benefits and reduction in reserve size may overstate what can realistically be accomplished through coordination.

D. NONECONOMIC BENEFITS OF THE SPR

The Strategic Petroleum Reserve also provides noneconomic benefits to the U.S. Primary among these is the capability of an active SPR program to reduce the effectiveness of the oil embargo as a political weapon. An active SPR program would demonstrably reduce the losses suffered by the U.S. during an embargo or other oil market disruption. For this reason, the embargo becomes a less powerful weapon in the hands of oil exporters. It is reasonable to expect that some types of interruptions (e.g., targeted embargoes) will in fact be deterred by an active SPR program.

Because the SPR lessens the effectiveness of the oil embargo as a political threat, it is possible that OPEC will act to undermine an active U.S. SPR program. Saudi Arabia especially may be displeased with an active U.S. stockpiling policy during periods, such as the present, in which they produce more oil than their stated preference.

There appears to be at least two ways the U.S. could mitigate an adverse OPEC reaction. First, we could accelerate the production of domestic reserves with the publicly stated purpose of placing the incremental volumes of oil in a domestic stockpile. Second, we could attempt to make our reserve less visible. Increased incentives for private sector stockpiling is one possible means of concealing an active stockpiling policy.

in the world oil market. Although the monetary transfers that normally occur during a disruption are desirable from the standpoint of economic efficiency, they are often viewed as inequitable. An SPR drawdown will lessen the magnitude of these transfers during a disruption.

The primary economic benefit of a SPR - the ability to lower oil prices during disruptions - was the only benefit attributed to the SPR program during the development of the policy conclusions and program guidance presented here. To the extent that the noneconomic benefits of the SPR are also desirable, the conclusions and guidance presented here understate the optimum level of SPR purchasing and drawdown activity.

IV. GUIDANCE

A. ACQUISITIONS FOR THE SPR

The Department of Energy should develop and propose an active program of crude oil acquisitions and drawdowns commencing in FY 1982. When it is possible to purchase oil for the SPR without affecting the world price of oil, acquisitions for the SPR should continue until the stockpile reaches a size of 1-4 billion barrels. Only when the current level of the stockpile is high, the current world oil market tight, and the future level of imports is expected to be low should stockpile acquisition be temporarily discontinued.

An acquisition or SPR fill rate of 200 million barrels per year (550 MB/D) is sufficient to capture for the nation most of the benefit potential of a federal stockpile program. One strategy which should be seriously considered is a long-term SPR contract for 550 MB/D of crude oil to be purchased from either a domestic or secure foreign source. Once the contract is established, the Department of Energy could then decide periodically whether the flow should be placed in the stockpile or temporarily diverted into the domestic market.

There are both legal and policy questions associated with the suggestion that the Department of Energy decide whether to divert SPR purchases to the domestic market. Many of the policy issues affecting such a decision must be coordinated with other agencies. In addition, the legislative authorities, staffing and skill mix

The timing and rate of a SPR drawdown should be determined at the time of the disruption. Such a determination should be based on a number of considerations, including the amount of oil in the SPR, the severity of the disruption and expectations about the likelihood of future disruptions. However, under a wide range of assumptions, PE analysis indicates that the economic benefits of the stockpile are maximized when the drawdown is initiated quickly and continued at a rapid rate.

Under the assumptions tested a large portion of the benefits of the stockpile can be captured, with a drawdown capability of 730 million barrels a year (2.0 MMB/D). However, under a different set of assumptions (more frequent severe disruptions, but of short duration) considerably higher drawdown rates can be justified. Since the primary benefit of the SPR program is the downward pressure it exerts on all oil prices when it is released, competitive sales, rather than direct allocation, is the preferred method of releasing SPR oil during a disruption.

C. COORDINATION WITH OTHER IEA MEMBERS

Programs which enable the International Energy Agency (IEA) member nations to coordinate their stockpiling activities can produce large benefits for all members, including the U.S. A program which allowed all the IEA members to depend on a common stockpile management program would allow the U.S. to maintain a 30% smaller stockpile while enjoying 100% greater net benefits from the program. The U.S. should seek agreements with the members of the IEA that would permit coordination of the acquisitions and drawdowns of the member nations.

OIL

I. GOAL

The Department's goals for the oil programs are described in detail in the overview. In summary, these are to reduce oil imports by encouraging domestic oil production and restraining domestic demand for petroleum products.

II. PROGRAM

The phased decontrol of domestic crude oil prices coupled with a Windfall Profits Tax is the major program for achieving the Department's oil policy goals.

On June 1, 1979, President Carter initiated a 27-month program of phased decontrol. By October 1981, all price controls on domestic crude oil and refined products will be eliminated.

At the same time that the President announced his intention to decontrol crude oil prices, he proposed a Windfall Profits Tax to capture for the government a portion of the increased revenues accruing to domestic producers as a result of his decontrol decision. The Administration's Windfall Profits Tax proposal is still being considered by Congress.

III. ANALYSIS

The President's phased decontrol of domestic crude oil prices will reduce petroleum imports. It will achieve this by increasing domestic production of oil and reducing consumer demand for petroleum products. PE analysis indicates that by 1985 decontrol coupled with the Administation's version of the Windfall Profits Tax will increase domestic production of crude oil by 0.8-1.2 million barrels per day above what would have been produced under a continuation of controls. By 1990, the increase in domestic production is expected to be 1.0-1.8 million barrels per day. The reduction in domestic consumption attributable to decontrol will also be substantial. By 1985 decontrol will reduce domestic petroleum consumption by 0.3-0.5 million barrels per day. By 1990, the reduction is estimated at 0.5-0.9 million barrels per day.

trol will have several other very significant benefits. It encourage the production of petroleum substitutes. And ly, it will eliminate the administrative, enforcement, and iance costs associated with the price controls program.

GUIDANCE

the phased decontrol of crude oil prices will be completed tober 1981, there is no program guidance for the decontrol am. Program guidance related to the Windfall Profits Tax await completion of Congressional action on the measure.

THER PROGRAMS

programs include enhanced oil recovery and accelerated ng and land acquisition in order to increase domestic oil es. In addition, the President has adopted a permanent oil ceiling of 8.5 million barrels per day and has set an oil ceiling of 8.2 million barrels per day for 1980.

Natural gas currently plays an important role in domestic ener
markets for two reasons. First, natural gas currently provide
a quarter of total U.S. energy supply. Second, natural gas ca
as a technical matter, easily displace imported oil in large
portions of the industrial and electric utility sectors. In t
future, large uncertainties exist about the size of contributi
of natural gas to total U.S. energy needs. Estimates range fr
22 to 24 percent in 1985 and from 15 to 20 percent in 2000.[1]

Historically, the government has regulated large portions of t
natural gas industry. Wellhead prices of natural gas in the i
state market have been regulated since 1954, and in the intras
market since 1978. The Federal Energy Regulatory Commission (
regulates interstate natural gas pipelines while state governm
regulate local distribution companies and intrastate pipelines
The Natural Gas Policy Act (NGPA) of 1978 provides for the der
ulation of wellhead gas prices for new natural gas by 1985. H
the transportation and distribution of natural gas will contin
to be regulated because the government has granted a monopoly
the providers of these services. This regulation has an impor
effect on the incentives to conserve natural gas.

The United States is unusual in the extent to which it uses
natural gas. Whereas gas production is only one-fourth the oi
production on a Btu basis in the rest of the world, it is roug
equal to the oil production in the U.S. Geology does not acco
for the differences between the U.S. and the rest of the world
Because of its vast potential, gas could play a strategic role
reducing demand for OPEC oil worldwide.

II. GOVERNMENT OBJECTIVES

A. OIL IMPORT REDUCTION

Because natural gas can substitute for imported oil in a wide
variety of end use sectors, natural gas policy can have a majo
effect on the U.S. demand for imported oil. First, to encoura
oil import reduction, the U.S. should encourage the production
of gas which is economic at world oil prices. Two principles

market-like mechanisms should be employed. In the natural gas area, government policies should be designed to:

- ensure the decontrol of wellhead prices of natural gas

- reduce the likelihood of temporary market distortions when decontrol occurs

- ensure that appropriate market signals for conservation and production are given, especially during the transition to decontrol

- ensure that users with higher economic values for gas receive the gas before users with lower economic values.

These policies must be pursued with due regard for the equity concerns associated with removing Federal price controls. The major equity debates over natural gas policy have involved rent transfers from consumers to producers and the sharing of higher wellhead prices among consumer classes. Second, the nation can benefit by applying a consis premium to the reduction of oil imports. To the extent that increment natural gas supplies reduce oil imports, the U.S. should be willing to pay a premium to increase the supply of or reduce the demand for natural gas. In applying this premium, the environmental advantages of natural gas over other oil substitutes (such as coal and synfuels) should be considered. In considering the value of additional natural gas imports, security considerations play a key role, depending on the exporting country.

B. LONG-RUN PLANNING UNDER UNCERTAINTY

In addition to direct oil import reduction strategies, the U.S. should obtain information about:

- the size of the conventional and unconventional natural gas resource base

- new gas technologies, both for production and conservation.

Reducing uncertainty about the longer term availability and price of natural gas is important for two reasons. First, natural gas is transported and used in facilities which have long physical lives.

gas available on the world market is vast. Substantial quantities of gas are now flared in the process of oil production in the Persian Gulf Region and in more secure areas such as Mexico. In addition, the ratio of known available reserves of natural gas to current production is much larger than the same ratio for oil. The benefits of additional world gas supplies are analagous to the premium benefits associated with reduced domestic oil imports. Increased production has the potential for lowering the world market price of both oil and gas and thereby reduce the total cost of U.S. oil and gas imports. If, however, joint production decisions are made by Persian Gulf oil producers, additional gas production may not result in a price reduction. To the extent that gas can be obtained from secure sources, additional production also increases the security of the world oil and gas markets from short-run disruptions. Even increased supplies of gas from insecure sources might have some security value if those supplies reduce the demand for oil and increase the amount of excess capacity in the oil market. In this latter case, the benefits of increased gas supplies must be weighed against the risk associated with increased gas production from insecure sources.

As in the case of foreign oil supplies, intervention in the gas market is justified only to the extent that it secures greater production than would have occured without intervention. Otherwise, the U.S. simply ends up paying more for these resources than is necessary to secure their supply. Intervention is probably justified in those cases in which institutional barriers make it difficult or impossible for producing states and private firms to reach acceptable agreements. These institutional barriers are particularly important in the international gas market because of the size of the capital investments required and the relatively fixed patterns of trade implied by pipeline transportation and the location of liquified natural gas facilities. In addition, government participation in such trade agreements is required because of the regulated character of the U.S. gas market.

III. GOVERNMENT PROGRAMS

A. CURRENT ADMINISTRATION POLICY

1. Wellhead Price Controls

2. Natural Gas Markets

In the long run, natural gas should be displaced with coal in electric utility and industrial boilers. The Fuel Use Act (FUA) should be implemented to reflect the premium for reducing natural gas use in coal capable uses corrected for the environmental degradation resulting from coal use.

In the short run, FERC's Order 30 and ERA's certification of eligible users program eases regulatory restrictions by allowing gas to displace imported oil in the electric utility and industrial sectors where use of coal currently is not feasible. This program is designed to reduce stresses in oil markets (like the one created by the Iranian situation) by using the gas "bubble" from the intrastate market to reduce oil imports.

DOE encourages states to hookup new residential customers where they place a high economic value on natural gas, and where such hookups are consistent with efficient gas distribution policies. Finally, although the Administration opposes any amendments to the Natural Gas Policy Act at this time, FERC is going forward with implementation of the act's incremental pricing provisions.

3. Conservation

The Administration supports natural gas conservation through several legislative initiatives currently under consideration by Congress. These proposals rely primarily on loans and direct subsidies to promote conservation rather than on pricing reform.

4. Supplementals and Imports

In general, DOE compares the cost of supplemental supplies and imported gas to the expected price of imported oil over the life of the project. DOE has encouraged FERC to allow natural gas from tight sands to receive an oil-equivalent price, supported special tariffs for the Great Plains High-Btu Coal Gas project, and approved imports of natural gas which cost less than imported oil and were consistent with our national security. DOE supports the Alaskan gas transportation system because it will cost less than imported oil over the life of the project, and believes that the nation will benefit from the project, even if private financing is not

Finally, the Department funds R&D for unconventional natural gas, including $77 million in 1979 and $71 million in 1980. Activities include resource appraisal, technology development, and demonstration facilities. For geopressured methane, the effort also include well drilling to establish the resource potential and to solve technical and environmental problems.

B. POLICIES WHICH COULD BE PURSUED BY THE GOVERNMENT

Four basic policy directions are consistent with the objectives described above, but are not part of current policy.

- Review of the wellhead pricing provisions of the Natural Gas Policy Act in light of the recent dramatic world oil price increases

- Reform natural gas pipeline rate structures to reflect replacement costs

- Introduce market-like mechanisms (explained below) in the final consumption sectors to allocate natural gas during shortages

- Encourage retail rate structures which promote conservatio especially in the residential and commercial sectors.

Market-like mechanisms are mechanisms which use market signals, nam price, to allocate gas to lower-priority users.

IV. ANALYSIS

A. CURRENT POLICY

1. Effects of the Pricing Provisions of the NGPA

Recent increases in world oil prices create a paradox for pursuing the aims of the Natural Gas Policy Act. On the one hand, higher oil prices make the decontrol of natural gas prices even more critical to achieving national energy objectives. On the other hand, higher prices complicate the problem of creating an orderly transition to decontrol. Greater effort may be required to avoid

policies can be designed to address the new situation created by substantially higher world oil prices.

2. Natural Gas Markets

Substantial uncertainties exist about future supply and demand for natural gas. The Department's programs operate under the assumption that if natural gas supply is increased, or if natural gas demand is decreased, the gas will be used to displace imported oil in the industrial or electric utility sectors. Consistent with this view, the Fuel Use Act should be implemented to reflect the oil import reduction premium associated with reducing natural gas use. The premium should be applied consistently across all supplemental gas projects as well, with appropriate corrections for environmental penalties.

3. Supplementals and Imports

Treatment of supplementals is not always consistent. While the cost of supplemental gas supplies is usually compared to the expected cost of imported oil, the premium for natural gas has been applied to some sources of natural gas (unconventional) but not to others (conventional, Alaskan, High-Btu coal gas). Decisions on LNG projects have explicity considered the security of the source of supply.

To date, DOE has not specified a broad policy with respect to using the "old gas cushion" to subsidize new technologies, although the endorsement of rolling-in the costs of the Great Plains high Btu coal gas project is one example of this practice. Such policies should be pursued with care because of the efficiency losses which may be caused on the demand side by such practices.

Given the high prices certain deregulated categories of unconventional gas can now command, it may be appropriate to reconsider whether the private sector will do much of the R&D currently being performed by the Government.

B. NEW POLICIES

Section 123 of the NGPA requires DOE to report to Congress just prior to control on the state of the natural gas market. In

higher world oil prices, make it important to examine the issues posed by Congress at this time as well.

In the next year DOE will have a number of opportunities to improve the transition to a more orderly gas market. Key among them are the natural gas rate design study mandated by the Public Utility Regulatory Reform Act of 1978, the curtailment policy review, FERC's implementation of Title II of the NGPA (incremental pricing), and decisions on the treatment of natural gas in FUA. Policy proposals which deserve careful analysis and review in the next year include:

- NGPA wellhead pricing provisions

  -- Decontrol all natural gas and apply a "windfall profits" tax on old gas.

  -- Index the new gas price trajectory to the world oil price.

- Pipeline Rate Reform

  -- Place deregulated volumes on a separate rate schedule, so that distribution companies see the incremental costs of additional supply, and

  -- Encourage distribution companies to use "lifeline" or inverted block rates for high priority users (explained below) to encourage conservation.

- Pipeline Rate Reform and End Use Market Mechanisms

  -- Option 2 above, plus use of market-like mechanisms to allocate the gas in the industrial sector during periods of shortage or market imbalance.

  -- Review existing federal regulations and policies to determine ways to facilitate the movement of excess natural gas between systems.

Lifeline rates are structured so that each residential customer gets a "lifeline" quantity of gas at relatively cheap prices. However, the last units of consumption are priced at "replacement" costs. This "inverted" rate structure allows consumers to receive

prices and shall provide analysis of possible legislative proposals to modify the wellhead pricing provisions of the NGPA.

2. The Department endorses the concept of using pipeline rate reform and market-like mechanisms to ease the transition to decontrol and to give appropriate conservation incentives. In particular, on-going Departmental studies shall develop and evaluate specific policy options which use market-like mechanisms to solve allocation and conservation problems, including:

- The natural gas rate design study. (ERA)

- The curtailment policy review. (ERA)

Because these studies are required by law and are the major on-going vehicles to formulate natural gas policy, they are considered particularly significant opportunities to develop new proposals in these areas.

3. Unconventional gas appears to be commercially viable at today's world oil prices based on current technologies and cost estimates. In light of this, FE shall give specific consideration to why Federal R&D is necessary in the unconventional natural gas area given the prices these categories of gas can command in today's market. Particular attention shall be paid to the benefits of resource appraisal by the government. Where the program office claims that increased production of unconventional gas, as well as information about the resource, will result from the government's R&D efforts, FE shall explicitly consider and quantify the benefits of this additional production.

4. The premium for oil import reduction adjusted for environmental benefits shall be used uniformly to assess all proposed domestic supplemental gas projects and to compare proposed domestic gas projects to other oil-substitutes (such as synfuels).

5. Guidance for synthetic gas is covered in Section E on synthetic

Nuclear energy, unlike other energy resources, is uniquely associat
with the production of electricity. Thus, the beginning of policy
discussion must be an overview of the electric sector which nuclear
serves.

Until the early 1970's the growth of demand for electric energy was
and predictable, ranging from 7% to 10% per year. This was a perio
declining real prices. As a result of economies of scale for fossi
generating stations and declining fuel costs, the real price of del
electricity by 1970 was only 60% of that in 1949.

But by the early 1970's, this situation was reversed, the result of
economic and technical forces whose interaction is not yet well und
The delivered price of electricity rose almost 50% in real terms fr
1970 to 1978, in large part due to rising fuel costs. At the same
the stable pattern of demand growth was seriously disrupted, and ut
found themselves unable to predict demand with accuracy, even on an
annual basis. The data below show how utilities systematically ove
demand, even in one-year forecasts.

TABLE C-1

Utility Forecasts Made the Preceeding Year Compared
with Actual Demand

	1968	1969	1970	1971	1972	1973	1974	1975	1976
Predicted Increase %	11.4	8.5	9.4	10.8	11.8	10.6	8.8	9.1	9.2
Actual Increase %	11.5	8.3	6.6	6.4	9.3	7.8	1.6	2.2	4.0

Source: Edison Elecric Institute

importance despite long-term growth rates significantly lower than t
heretofore experienced.

TABLE C-2

Long-Term Electric Growth Rates

EIA Series C Forecast For:	Average Annual Growth Rate (%) 1977-1985	1985-1990	1990-1995
Real GNP	3.7	3.0	2.9
Primary Energy Supply	1.8	2.5	2.5
Electricity Production	4.6	4.0	3.7

Source: Energy Information Administration, October 1979

II. NUCLEAR ENERGY FORECASTS

The salient feature of nuclear energy forecasts has been their systema decline. Although the excesses of the past (forecasts up to 1000 GWe installed nuclear capacity by the year 2000) are now widely recognized there has been a continued erosion of even recent forecasts that had been considered conservative. For example, the 1977 EIA Annual Report predicted that from 200 to 275 GWe of nuclear capacity would be on lin in the U.S. by 1995. By contrast, unofficial EIA estimates made in October 1979 placed the range at 156 to 196 GWe. Since 1975, the numbe of new plant orders has been exceeded by cancellations as shown in Tabl 3.

TABLE C-3

Net Orders for Nuclear Generating Capacity

YEAR	ORDERS		CANCELLATIONS		NET CHANGE	
	No. of Units	Capacity (MWe	No. of Units	Capacity	No. of	Capaci

nd which remain controversial today. Foremost among these are the afety of nuclear generating plants, the competence of the utility ompanies to manage these plants, the storage and disposal of radioactive aste, and the potential misuse of the commercial nuclear fuel cycle as source of nuclear explosives.

ne second causal factor is the apparently weakened financial structure the electric utility industry, attributed in part to rising capital harges and rate increases which have not kept pace with the expectations the utilities or their capital markets. This provides economic ncentives for utilities to defer construction of capital-intensive nvestments such as nuclear generating stations.

nird, the mid-term and short-term demand for electric energy has dropped ell below utility forecasts. This has left many utilities with excess enerating capacity and the opportunity to improve near-term cash flows slowing or deferring construction.

nd fourth, nuclear energy in itself has become a controversial political ssue. This adds political uncertainty to the economic and technological ncertainties described above.

I. THE ROLE OF THE GOVERNMENT

A. OIL DISPLACEMENT

oughly 10% of the oil used in the U.S. is burned in utility steam ants, 1.8 million bbl/day in 1977. Many of these plants are nominally eaking units, but delays in the completion of coal-fired and nuclear nits have caused these plants to be used in intermediate and even base-oad roles. Others are designed specifically for intermediate or base-oad use.

uclear energy can directly displace much of this oil. For example, stimates suggest that the nuclear units scheduled to enter commercial peration between now and 1982 will directly displace 250,000 bbl/day of il.1/ To the extent that utility systems are interconnected to allow east-cost electricity to be distributed among utilities, this quantity ay be increased.

in its technical capabilities, operator and supervisor training, and management discipline.

Recognizing that the basic responsibility for safe and reliable operatio rests with the industry, the appropriate role of the Department of Energy is one of technical and management assistance. Specifically, DOE should work to strengthen the nascent technical institutions which the industry began as a response to the Three Mile Island (TMI) accident. The Department (ASNE) should develop a strategy which works through such institutions to:

-assess the total manpower and training requirements of the nuclear utilities;

-develop a program for upgrading and accrediting training institutions;

-disseminate and interpret the data on operating experience gained by NRC, DOE, and the industry itself;

-identify appropriate technologies that could improve the operational safety and reliability of nuclear plants;

-gain and disseminate the maximum amount of relevant technical data from analysis of the TMI accident.

An essential element in such a strategy is a means to measure the extent to which the industry has improved its technical and managerial capabili and a criterion for the withdrawal of Federal involvement.

Beyond the utility use of nuclear power, its application should be considered for industrial process heat, district heating, and generation for electric vehicles. A market study of the potential of nuclear to displace oil in these applications should be conducted (ASNE).

Finally, DOE (through ASEV) should continue to support research on the late biological effects of low-level radiation.

led to their deferrment. Now, it is clearly the intent of the Preside and the Congress to address them without delay. This does not imply that final solutions must be immediately forthcoming; it does, however imply that a program which leads to such solutions must be put in plac without delay.

1. Nuclear Waste Management

Two principles are important in nuclear waste management. First, custodianship is ultimately a government responsibility,2/ since the time over which radioactive material remains hazardous extends beyond the reasonably expected life of private institutions. Second, those wh derive benefit from the activities which generate nuclear wastes shoul pay the present value of the cost of such custodianship. Within these principles, the goals of nuclear waste management are:

-to contain and control for the indefinite future those wastes which now exist or are being produced;

-to develop scientific understanding and program capabi leading to the permanent disposal of nuclear wastes in a manner that provides high confidence of their permanent isolation from the biospher

The former is addressed by DOE custodianship of defense waste and by legislation which would provide interim storage for commercial spent fuel. With regard to the latter, there is a need for a clear and syst strategy to:

-complete development of the scientific basis for nucle waste disposal;

-demonstrate how the technologies for waste disposal ca be integrated to assure system compatability;

-display the key decisions in the disposal strategy and the environmental reviews and impact statements needed to support them

-integrate logistical and interim storage consideration into the disposal strategy;

-integrate the state consultation process into the dispo l st at gy d esol t e u isdictional aspects of the siting

he widescale use of plutonium until international institutions can be
trengthened to deal with the proliferation issue. In particular, the
.S. has deferred: (a) the reprocessing of spent nuclear fuel and the
ecycle of plutonium in light water reactors; and (b) the commercializatio
f the breeder reactor.

n addition, this is being accomplished by improving safeguards systems
or nuclear fuel cycle facilities, closely examining the export or
ransfer of sensitive technologies, limiting research reactor material
o enrichment levels that minimize the presence of weapons-usable material
nd creating non-proliferation incentives by demonstrating that the U.S.
s a reliable supplier of nuclear fuel and fuel cycle services.

inally, the International Nuclear Fuel Cycle Evaluation (INFCE) was an
arly step in developing the technical basis for international consensus
n non-proliferation policy. The work begun in INFCE will be carried
orward in other international forums. Such work includes study of
nternational plutonium storage, spent fuel management systems, and the
rovision of fuel assurance by uranium stockpiling.

commercial breeder introduction. This is a function of:

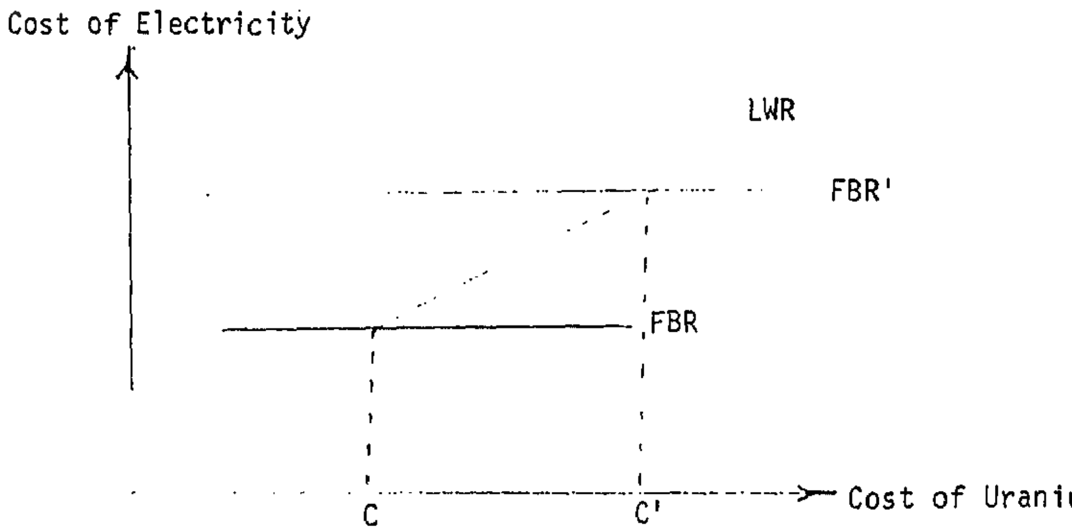
-breeder capital costs, which are expected to exceed those of the light water reactor (LWR) by a factor of 1.25 to 2.0;

-the cost and availability of uranium ore.

The relationship between these variables is shown conceptually in Figure 1. The vertical axis measures the cost of elecricity and the horizontal axis the cost of uranium.

FIGURE C-1

Cost Comparison of Breeder and Light Water Reactor



present estimates suggest that C is above $150/lb and perhaps higher than $250/lb. This compares with the current spot market price of around $40/lb.

Because of the non-proliferation concerns discussed earlier, it is desirable to avoid the premature commercial deployment of the breeder fuel cycle. Thus one goal of nuclear policy is slow movement along the horizontal axis, thus delaying the year at which point C is reached.

This date is a function of: (a) the rate of deployment of nuclear generating capacity, (b) the efficiency with which that capacity consumes uranium; and (c) the rate of discovery of new uranium. Using the previou discussed nuclear growth forecasts for the first of these, the technology programs of DOE should seek to accomplish the following.

1. Efficiency of Light Water Reactors

Present LWR's consume between 5000 and 6000 tons of uranium, depending largely upon capacity factor, over a 30 year life. It is possible to achieve a 15% improvement in the efficiency of uranium use through advanced fuels. A further 15% improvement might be achievable with advanced designs for new reactors and fuels. These improvements are not rapidly pursued by the industry because the non-proliferation benefits of delaying the widescale use of plutonium cannot be captured by individu firms. Thus, there is a need for government intervention to speed innovation beyond the rate impelled by the market.

2. Uranium Enrichment

Because of its early history and relationship to national security matters, the U.S. enrichment complex has remained a government enterprise Three technologies compete for production to support U.S. and foreign enrichment demand:

-Gasous Diffusion Enrichment Plants (GDEP). These three plants have recently been improved in efficiency and upgraded in capacity

-The Gaseous Centrifuge Enrichment Plant (GCEP). A single plant is now in the early stages of construction. This technology offers an electrical efficiency improvement by a factor of 20, and thus would significantly reduce the consumption of electricity per unit of enrichment.

re are two specific issues within the enrichment area which require us and resolution. The first concerns the appropriate deployment of ichment technologies over the approaching 15-year campaign period, to imize cost while maximizing production effectiveness. This issue was st addressed within the context of FY 1981 budget considerations ated to the GCEP, but requires further analysis in preparation for FY 1982 budgetary decision-making process. The specific elements ch need to be considered are:

-An up-to-date and realistic estimate of U.S. enrichment duction requirements over the campaign period, based upon estimated . and foreign nuclear capacity growth. The EIA projections for lear growth should be considered in such planning.

-A definition of the relative sensitivity of the enrichment hnology deployment strategies to the forecasted enrichment demand.

-Identification of the economic trade-offs between technologies ed upon capital, power and other operating costs.

-An estimate of real power cost increases expected for enrich-t production over the campaign period.

-A definition of various deployment strategies and their ociated economic advantages and disadvantages.

second issue concerns the ability of the U.S. to influence inter-ional non-proliferation policy and the requirement that the U.S. be ceived as a reliable nuclear fuel supplier. The specific issue cerns the definition of fuel and production capacity reserves required the U.S. to achieve its non-proliferation goals and assure fuel ilability, while minimizing cost. The particular elements which need be taken into consideration are:

-A realistic assessment of international enrichment production ns on a country specific basis.

-A realistic assessment of international enrichment demand on ountry specific basis.

-A determination of minimal U.S. reserve levels required to ieve U.S. goals.

It is important, however, to understand ... total shape of the resource supply curve, i.e., resource availability in the area beyond \$100/lb. (the area of interest for breeder reactor economics) as well as below. Most of the uranium resource evaluation has been focused on lower cost resources. In addition, most of the uranium ore discovered in the U.S. occurs in sandstone. By contrast, most of that outside the U.S. is in non-sandstone deposits. DOE should continue to study these "world class" geological formations to ascertain whether similar deposits exist in the U.S. The particular consideration which need to be made are:

-Definition and consideration of the marginal cost-benefit of continued NURE emphasis on estimation of low cost resource levels.

-Design of additional estimation procedures to identify resour levels associated with high cost (\$100/lb and above) and "world class" resource levels.

4. LMFBR Program

The Fission Strategy Paper of the Department of Energy indicates that under reasonable forecasts of nuclear capacity growth and with the technological advances discussed above being brought to fruition as expected, it is unlikely that a commercial breeder reactor will be economically desirable before roughly 2020. This is true even without expansion of the ore base beyond present estimates of 4.5 million tons (at a forward cost of \$50/lb or less). This implies that a demonstratio of FBR technology is not needed at this time. Thus efforts to terminate the Clinch River Breeder demonstration project should continue. The LMFBR program should plan to continue at the approximate level of the proposed FY 81 budget for the near future.

Carter said, " We can protect ourselves... by making the most of our abundant resources such as coal...." Nearly two years later, on Apri 1979, the President emphasized the extreme importance of coal for sho term needs. He stated that during the "transition" to full-scale dev opment of alternative technologies, coal "would be our most important source of fuel."

Despite National policies to increase its use, coal is demand limited Coal accounts for about 18% to 19% of domestic energy consumption tod the same level as over the past several years. Productive capacity however, exceeds demand by over 100 million tons per year.

Demand for coal is expected to increase at an average annual rate of 5.1% through the year 2000, from 664 million per tons per year in 197 1.4 billion tons a year in 1990, and 2.0 billions tons by the year 20 This compares to an average annual growth in demand of 2.7% between 1 and 1980.

Demand for coal by sector is projected below:

Table D-1
Coal Forecasts by Year 1/
million tons of coal equivalents 2/

	1978	1985	1990	1995	2000	1978-2000 Ave. Annual % Change
Industrial	142	240	300	360	390	4.7
Utilities	481	680	990	1100	1170	4.1
Synfuel	0	3/	40	130	330	
Exports	41	80	90	100	110	4.6
Total 4/	664	1000	1420	1690	2000	5.1

1/ Source: Updated NEP II Base Case
Office of Analytical Services, PE 12/31/79
2/ ton = 22.5mm btu
3/ very small but non-zero amount

would result from slower progress in developing synthetic fuels.

Table 0-2
Coal Forecasts by Year 1/
million tons of coal equivalents 2/

	1978	1985	1990	1995	2000	1978-2000 Ave. Annual % Change
Industrial	142	210	250	280	290	3.3
Utilities	481	640	760	770	830	2.5
Synthetics	0	3/	30	89	230	
Exports	41	80	80	100	110	4.6
Total 4/	664	930	1130	1240	1460	3.7

1/ Source: Updated NEP II "Low Coal/Nuclear Case
2/ ton = 22.5mm btu
3/ very small but non-zero amount
4/ total may not sum due to rounding error

Coal demand is expected to increase more rapidly in the future due to an improved competitive position vis-a-vis other fuels. Whereas, betw 1976 and 1978, the average nominal cost of coal delivered to utilities increased 32% compared to an oil price increase of 9%, future coal pri are expected to grow more slowly than oil prices. Under planning assu tions adopted for this paper, coal prices are expected to increase at slightly more than 0.5% per annum real between 1980 and 1995, and oil prices at slightly less than 3% per annum. The slower rate of growth coal prices is explained by the fact that the coal market is more comp itive than the oil market and coal prices are likely to track coal production costs, which are expected to increase less rapidly than oil prices. Another point of view, which differs from our planning assump tions maintains that coal prices will increase more rapidly, perhaps a the same rate as oil price growth. For purposes of planning, it is necessary to take into account the uncertainty in future coal price gr rates. Future coal production is expected to increase to approximatel 1.0 billion tons in 1985 and keep pace with demand thereafter.

affect real increases in the cost of producing and utilizing coal supplies. It will also support development of more cost-effective metho to mine and transport coal in an environmentally acceptable manner, and assure the health and safety of mine workers." The DOE Report on Increa Coal Production and Use indicates that

- "in the near term, increases must depend upon greater conventional use of coal in the utility and industrial sectors," and

- "in the long term, additional increases in coal use will depend upon new, non-conventional coal technologies and adequate coal production from federally-owned western lands where most future increases in production will occur."

II. DOE POLICIES TO CARRY OUT NATIONAL GOALS

A. PRODUCTION

The DOE has a limited ability to influence the cost and level of coal production. The Department of Interior is responsible for coal leasing and for regulating the way in which coal lands are reclaimed. The Department of Labor regulates the safety aspects of how coal is mined. DOE can comment on DOI and DOL regulations.

Mine operators and mining equipment manufacturers have profit incentives to increase coal mining productivity and reduce mining costs. DOE can develop new mining techniques to reduce costs and facilitate the ability of the coal industry to meet environmental requirements and overcome institutional barriers. To the extent that these latter activities compete with similar industry efforts, they would have little incremental economic benefit because they do not reduce oil imports.

The government must take a strategic approach to the mining RD&D program taking into account the resource base, the need for increased productivi the type and physical characteristics of coal seams, the mining company size and the environmental considerations. These should be categorized and a systems approach developed to serve the needs of those categories or resources with sufficient economic coal reserves to benefit from the program.

A special consideration is that the environmental constraints on Western coal production have increased significantly over the past several years

for determining coal ... which will meet their targets. The tracts currently under consideration for the initial sales may not be the most desirable in terms of the quality and type of coal needed or promixity to the utility and/or industrial market. The Resource Application Leasing Office, with support from Fossil Energy, should work as closely as possible with DOI so that the Nation is insured that the most suitable tracts of land are offered for sale in order not to constrain the Leasing program.

In addition to the strategic approach described above, the Department's mining programs should provide sufficient technical data for the Department to ensure that regulations issued by DOI & DOL do not result in either unwarranted coal production cost increases which would reduce the competitive position of coal or limits on the amount of coal to be mined, thereby increasing rents available to coal landholders.

B. COAL USE

1. Near Term Coal Use

a. Fuel Use Act in General

The Powerplant and Industrial Fuel Use Act (FUA) will be used to require use of coal (or other alternative fuel) in all new electric utility powerplants and major industrial fuel burning installations (units with a heat input of 100 million Btu's per hour or more or groups of units with combined heat input of 250 million Btu's per hour or more), and in existing coal capable facilities, subject to statutory exemptions. The statute does not require coal use where the costs of using coal would "substantially exceed" the cost of using imported oil. In making that cost determination, FUA regulations, orders and exceptions should reflect both the value of domestic energy use that displaces imported oil, and the environmental degradation that can result from coal use.

FUA requires private sector parties to bear higher costs and thereby to purchase benefits for society as a whole. Because costs are not spread widely and are not voluntarily incurred, a conservative approach to estimating costs and benefits is appropriate under FUA. Only significant benefits which are reasonably certain to exist, and which can be quantified, should be estimated.

Proposed and interim final rulemakings under FUA have combined three benefit factors and one cost factor in determining whether the costs

These recent price increases have also improved the prospects for coal u
in large new utility and industrial boilers. It is expected that price
ill be the primary mechanism which will drive the industrialization eff
in direct coal combustion and that the relative economics of coal versus
oil and gas for large new boilers will discourage the use of oil or gas
almost all cases where coal use is physically and environmentally feasib
Although actual experience with the program will be needed to make a fin
determination, FUA regulation of these decisions may prove to be unneces
Because of the changed situation since FUA was enacted and the dynamic
nature of the energy and environmental situation, final rules under FUA
should provide for periodic review of the effectiveness and appropriaten
of existing regulations and legislative provisions. Existing FUA proced
requirements will be reviewed as expeditiously as possible to determine
areas in which regulatory burdens can be reduced, for example, by substi-
tuting certification for evidentiary procedures.

b. Industrial and Utility Coal Conversion

One hundred-seventeen coal-capable powerplants have been identified. If
all of these plants were converted to using coal, over 74 million tons o
additional coal would be used. However, only about 60 of these may be
convertible due to technical, economic or institutional reasons. It is
unlikely that more than 40 million additional tons of coal will be
used by these utilities.

In selecting and ranking candidates for conversion orders, two primary considerations will be (1) the potential for oil savings; and (2) the physical and environmental ease of conversion from a technical and economic point of view. The effects of a conversion on the potential for construction of new coal capacity in an air quality non-attainment area will be considered. Approximately 60 conversion orders will be issued in FY 1980, and 15 in FY 1981. In addition, all electric utility systems will be required to reduce use of oil and natural gas in boilers by 50% by 1990 under legislation proposed by the Administration.

Primary emphasis in the coal conversion program should be on the use of additional resources provided ERA to carry out the statutory provisions
FUA.

commercial acceptance of a new technology that may offer major benefits the utility sector, RD&D options for near-term (pre-1990) implementation should be limited to improving already available commercial technologies and to accelerating the commercial acceptance of emerging technologies through engineering improvements -- Coal-Oil Mixtures, Environmental Control Technology, and Physical Coal Cleaning. Commerical acceptance o these technologies will enhance the FUA regulations by reducing the numb of facilities exempted from the regulations. These activities should be conducted aggressively to improve the operating characteristics (e.g., reliability) of those technologies that reduce oil imports in the near term. Beyond this limited RD&D, the Federal role is limited to obtainin relevant data to support the enforcement of the FUA. Primary emphasis i on cooperating with utilities in order to obtain cost and operating data relevant to ERA rulemaking. Demonstrations should be performed only when the private sector is regarded as not willing to demonstrate a technology without direct Federal support and when the near-term oil import savings justify an increased premium above that in the FUA.

2. Near-term Industrial Use

It appears that significant portions of the new boiler market can be economically penetrated by conventional coal-fired boilers at oil prices between \$20 and \$30 per barrel. Successful enforcement of the FUA with the ERA-proposed economic testing would result in coal capturing almost the entire new large boiler market. For existing boilers, early retirements to take advantage of coal's lower costs are likely when oil prices are greater than \$30/barrel.

In the past, major uncertainties perceived by industrial management in future fuel prices and availability and in Federal energy and environmental policy, have caused them to postpone decisions to construct new boiler capacity or retire existing boilers. The effect of industrial reluctance to modify existing energy consumption patterns has already be seen in the relatively low level of industrial boilers purchased over th past few years. The 1980-1990 period, however, may see a fairly strong market for industrial boilers as postponed purchase decisions from the previous time period will likely supplement the projected purchases show in Table D-3.

	1980	1980-84	1985-89	1990-94
Retirements		0.6	0.7	0.8
New Additions		1.0	1.1	1.3
Total	3.8±0.2	1.6±0.4	1.8±.4	2.1±0.5

(a) Figures reflect impact of environmental restrictions on coal use du to industrial locations in non-attainment areas. Do not include economic or institutional barriers that may force use of oil or gas.

(b) Estimated fuel input of existing oil and gas fired boilers located in attainment areas plus 20% of boilers located in non-attainment areas.

Higher oil prices recently have resolved many of the uncertainties related to the construction of new coal fired boilers. Therefore, it is unlikely that DOE support of existing private sector R&D of new technologies could have a substantial impact on oil imports before 1990. In cases where uncertainties remain (e.g., for small Atmospheric Fluidized Beds) and where there is a demonstrated potential for coal use to reduce oil imports, DOE should accelerate development of improve technology to lower industrial resistance to coal use. Commercial demonstrations may be used if these appear to be the most influential stimulus to industrial acceptance.

d. Mid-and Long-term Federal RD&D

The mid and long-term (post 1990) Federal RD&D effort is driven mainly by environmental and economic decisions. As outlined above, the combin-ation of higher oil prices and existing technology should permit coal us in almost all large, new utility and industrial boilers under existing environmental standards. Analysis conducted by the Office of Environmen for the Office of Fossil Energy indicates that with current technology only, and assuming recently revised New Source Performance Standards, national annual emission levels in 2030 of sulfur oxides and particulate are projected to be less than the current levels even with a six fold increase in coal consumption in the utility sector.[1] However, levels of NOx, CO_2 ash, and sludge could increase substantially if new tech-nology is not introduced.

bed combustion, molten carbonate fuel cells, ...
environmental benefits appear possible if technology developmen
for high performance configurations can be attained.

On the other hand, moderate performance configurations of these
appear capable of attaining substantially improved environmenta
ance at costs comparable to currently commercial technology. T
the utility sector as early as possible with additional options
commercial facilities with improved environmental prospects and
flexibility in siting, the development program should, where ap
emphasize the development of moderate performance technology th
capable of evolving into high performance configurations. Deve
goals and demonstration plants may be established if these earl
urations can penetrate a sufficient portion of the utility sect
justify the costs of development and demonstration. In this re
of electricity should be comparable to existing technology and
must be identified in which the new technology would be economi
attractive because of its siting or other environmental attribu

IV. ENVIRONMENTAL CONSIDERATIONS

There are a number of legislative and regulatory policies that
constrain coal production or specific uses. Among these are Fe
environmental and ecological protection laws including the Clea
Act, the Resource Conservation and Recovery Act, and the Surfac
Control and Reclamation Act. Impacts will include disincentive
convert facilities (because of increased costs of environmental
constraints on new plant locations and sizes and uncertainties
pending or changing regulations.

In order that coal extraction and end use facilities be able to
the national environmental goals without significantly constrai
use of coal, EV should take the lead role in undertaking enviro
and health research based on the defined needs of RA and FE. F
should have the primary responsibility for developing new envir
control technologies. Each of these three offices should plan
coordinate with one another.

In addition to research and development on environmental and he
problems related to coal production and use, the Department mus
a position to reduce uncertainties and assess the effects and c
various environmental regulations affecting coal. The Departme
be able to assess the costs and benefits of roposed New Sour

I. INTRODUCTION

The United States has huge resources of coal, oil shale, and other materials which may be tapped through synthetic fuels production. Oil shale resources alone have been estimated as adequate to provide more than 400 billion barrels of synthetic oil, more than the reserves of the entire Middle East; the amount of coal available for conversion is sufficient to provide the nation's requirements for electricity, transportation, and industrial needs for a full century.

"Synthetic fuels" include solids, liquids and gases produced from coal and oil shale. Additional fuels often considered as synthetic fuels and referred to in synthetic fuel legislation include gases produced from unconventional sources such as Devonian shale and tight sands formations, and liquids produced from unconventional sources such as ta sands. Some synthetic fuel technologies have been employed in the last century (the United States used "town gas" or low-Btu gas, made from co and shale oil), and some have been employed in the last few decades (Germany ran most of its military forces in World War II on synthetic liquids). Synthetic fuel technologies employed currently include the SASOL process which makes gasoline and other products from coal in Sout Africa, unconventional gas sources which produce about 0.9 trillion cub feet annually from tight sands and Devonian shale formations, and the production of ethanol from biomass which is currently being marketed in several states combined with conventional gasoline to form "gasohol."

As the costs of conventional sources of energy rise, synthetic fuels will probably become economic. In addition to the technologies already use in America, oil shale is the synthetic fuel considered the most likely to be economically attractive at the earliest time; other technologies with the greatest near-term potential include the production o medium-Btu gas from coal, the conversion of medium-Btu synthesis gas in methanol and into Fischer-Tropsch liquids (as in the SASOL plants in So Africa), and the conversion of heavy oils and tar sands into clean and useful products. The cost of synthetic fuels is highly uncertain. The cost of oil produced from shale is estimated to fall between $26 and $4 per barrel; liquids produced from coal may cost from $24 to $45 per barrel; and gas produced from coal may cost, in energy-equivalent terms between $19 and $42 per barrel. (Source: DOE Resource Applications off for oil shale estimates; NEP-II figures adjusted to 1979 dollars for liquids and gas estimates.) In addition to cost uncertainties, be

the long run by obtaining information through R&D and studies of markets and industry structure, and by taking actions that will reduce the lead times necessary for developing a synthetic fuels industry.

II. GOVERNMENT ACTIONS

The first role of government relevant to synthetic fuels policy--fostering oil import reductions--involves the production of synthetic fuels through methods that are technically, economically, and environmentally feasible today. The second role--long-run planning under uncertainty--involves preparing the basis for future production by conducting research and development, obtaining information, and taking actions indicated by the new information that is obtained.

Government actions designed to foster oil import reductions in an efficien manner may not be the actions that are appropriate for conducting long-run planning in an efficient manner, and vice versa. For example, a governmen program designed to reduce imports efficiently might call for production from the lowest cost technologies (taking into account the value of the product, the differential environmental, health, and safety consequences of different technologies, and constraints on placing too many projects in a given geographic area). Learning the technical details, costs, environmental implications, and other information about new technologies in order to conduct long-run planning is best achieved through R&D projects at a scale much smaller than appropriate for commercial scale production. One <u>may</u> obtain information from a production program that is useful in long-run planning, but large inefficiencies can result. For instance, the cost of a new technology may be learned from construction of a commercial scale plant, but it would be more efficient to obtain cost information that is almost as good by funding a detailed design and cost estimate. The information obtained from R&D projects conducted at a scale much smaller than appropriate for commercial scale production is less accurate than information obtained from operation of a commercial scale facility. If obtaining information is the primary goal (rather than obtaining production from the lowest cost technologies), a decision whether to buil an R&D project or a commercial plant must follow from an analysis that weighs the value of the superior information from the commercial plant against the substantially greater cost of a commercial plant.

Most aspects of research and development are relevant to long-run plannin under uncertainty. However, two aspects are relevant both to long-run planning under uncertainty and to fostering oil import reductions: (1) A

two unresolved technical problems. In some cases, the private sector will have adequate incentive to conduct research and development to resolve those problems. (The private sector is generally more willing to conduct research and development when near-term payoff is possible.) However, in other cases the private sector may not have adequate incent and the government should conduct the research and development in order obtain oil import reductions as rapidly as possible.

A. OIL IMPORT REDUCTIONS

n order to reduce oil imports through synthetic fuel, the government should strive to meet the following objectives: (1) Encourage the production of synthetic fuels by private firms through providing incenti based on (a) the premium benefit for domestic production and (b) mitiga of the negative pollution, safety, and health effects associated with synthetic fuel production. The Overview presents the components of the premium, but indicates that a specific value has not yet been adopted. Pollution, safety and health may be handled by requiring controls analag to scrubbers on coal-burning plants which reduce harmful effects to the levels of other technologies, or by reducing the size of the incentives. At this time, there are no defensible estimates in terms of dollars of t negative effects from environmental, health and safety considerations. (2) Remove market barriers that prevent the private sector from respondi to incentives and regulations. (3) Obtain more information on the value of the costs of pollution, safety, and health effects associated with synthetic fuels production. This objective will allow the first objecti to be met with more precision.

The government has already taken several actions which start to meet those objectives. These include: (1) The creation of a $19 billion Energy Security Reserve. The bill specifies that DOE will provide financial assistance to stimulate domestic commercial production of alternative fuels. Specific appropriations in the bill call for the use of $1.5 billion for purchase commitments and price guarantees, $100 million for project development feasibility studies, $100 million for cooperative agreements with non-Federal entities, and $500 million as a reserve for defaults from loan guarantees. The bill was made into law only recently (December 1979), and specific implementing procedures have not yet been specified, although DOE is actively developing them. (2) The 20 percent investment tax credit for alternative energy facilities and equipment provided by the Energy Tax Act of 1978, a portion of which is currently scheduled to expire in 1982. The difference

Federal excise taxes of motor fuels containing alcohols derived from biomass. The effective subsidy for alcohol production is over $15 per barrel. (4) Exemptions for facilities using synthetic fuels from the conversion provisions of the Power Plant and Industrial Fuel Use Act. This provision does not give a subsidy to synfuels, but does allow a wider market for synthetic fuels than without the exemption. (5) Construction of the Great Plains Coal Gasification Project (headed by American Natural Resources). As is typical for regulated utilities, the cost of gas is paid by consumers even if it is greater than the price of gas available from other sources, or greater than the world oil price on an energy-equivalent basis. Under base case cost estimate the gas price will be the equivalent of $26 per barrel over the life of the plant. If the world oil price goes below $26, then the plant will subsidized in comparison to world oil.

Programs not currently in force but which stand a good chance of being adopted include: (1) The creation of a Synthetic Fuel Corporation. A bill to create what was originally termed the Energy Security Corporation is being considered by a House/Senate Conference. The bill calls for $88 billion to assume liabilities to facilitate the production, by 1995, of 1.5 million barrels per day of synthetic fuels. Draft legislation calls for incentives to be provided through the instruments of (in order of priority) purchase agreements and price guarantees, loan guarantees, loans, and joint ventures (e.g., through "government-owned, contractor-operated" plants). The priority ordering was selected to minimize the degree of involvement of the government in the projects. The draft legislation does not specify the amount of assistance to be provided a single project, and hence the effective per-barrel subsidy h not been set. The draft specifies that assistance should be provided t a range of technologies. It is specified that the range should include technologies making use of a variety of resources; aside from that criterion, no specific guidelines are established for how wide the range should be.

(2) The creation of an Energy Mobilization Board. This would be empowered to help cut red tape and facilitate regulatory decisions on maj non-nuclear energy projects. (3) The Administation has proposed two production tax credits--$3 per barrel for shale oil and 50 cents per million Btu's for unconventional natural gas. A more recent Congressiona proposal calls for the $3 per barrel production tax credits to be exten to synthetic liquids and gases produced from coal and a broader range o unconventional liquid and gas sources. The effective before-tax subsid for all these credits is roughly $6 per barrel. The credits would dimi

is based on the assumption that the proposed actions above will t[illegible]
effect. The first three guidance items are relevant to the DOE se
which will administer the Energy Security Reserve. To the extent
there is discretion over the choice of technologies, the guidance
also apply to DOE advice to the Synthetic Fuels Corporation:

-Guidance: The following criteria (in order of decreasing importance) should be considered in developing procedures fo awarding subsidies among synthetic fuel project proposals:

--Funds should be allocated via different instruments (p guarantees, purchase agreements, etc.) as specified in appropriations.

--Least cost technologies should be funded with high pri However, this criterion should be balanced with the ne fund a variety of different technologies, because (1) is uncertainty in cost estimates for the initial produ plants, and (2) the technologies that appear to be lea today may not be least cost in the long run. Costs sh course take into account the value of the product; dif environmental, health, and safety consequences of diff technologies; and constraints on placing too many proj a given geographic area. The value of the product sho include a component indicating the relative merit of l versus gases. (To the extent that gases cannot substi liquids, liquids have a higher value than gases in dis oil imports.) In addition, the number of technologies should be sufficient to provide reasonable assurance o meeting our production needs.

-Guidance: To the extent feasible, the determination of the cost technology should be left to a competitive, market-like For instance, price guarantees could be awarded by having ea bidder indicate what guaranteed price would be acceptable to and then having the government choose the bidders with the l acceptable prices. Purchase agreements could be awarded to who indicate they will accept the lowest amount of subsidy o estimates of future world oil price to be established by the of Energy. Loans and loan guarantees could be awarded to th willing to accept the smallest size of loan or loan guarante project of a given size. For purposes of awarding subsidies

-Guidance: Primary attention should be given to studies of the environmental effects of synthetic fuel production for those technologies with the greatest chance of being funded by the Energy Security Reserve or the Synthetic Fuels Corporation. All aspects of the technologies should be considered, including the conversion process, the output products, upgrading steps, production wastes, transportation, and end-use.

The following guidance applies to the Office of the Assistant Secretary for Policy and Evaluation within DOE:

-Guidance: DOE should develop draft legislation, in coordination with the Treasury Department, that calls for some combination of tax incentives to be extended beyond current cutoff points. (The 20 percent investment tax credit for alternative energy facilities and equipment is to be cut off in 1982; the production tax credits currently being proposed will phase out when the world oil price approaches $30 per barrel.) The combination could include a mixture of investment tax credits, production tax credits, and other provisions. The total per-barrel subsidy provided by the combination should not surpass the value of the premium.

B. LONG-RUN PLANNING UNDER UNCERTAINTY

The government should undertake the actions identified in the Overview of obtaining information and reducing lead times. Information may be obtained through research and development, and through other types of studies including those of markets and industry structure. Actions are to be taken which are deemed appropriate once the new information is gathered.

DOE and its predecessors have conducted vigorous research and development programs in synthetic fuels for many years. No demonstration plants have been constructed yet, but several are being decided upon, and some may be funded in 1980. They include one SRC I plant to produce solid and liquid fuels from coal; one SRC II plant using a direct liquefaction process to produce liquids from coal; two plants to produce high-Btu gas from coal, one of which could produce a liquid as a coproduct; two plants to produce medium-Btu gas from coal; and several to produce low-Btu gas from coal. Except for the low-Btu plants, each demonstration would cost from under one billion to two billion dollars or more, with half or more of the funding to be rovided b the government.

would allow the Administration to respond efficiently to a faster de
rate. The following guidance applies to the Office of the Assistan
Secretary for Resource Applications:

-Guidance: Consideration should be given to providing continge
planning to reduce lead times for the development of syntheti
fuel technologies at a much more rapid pace than is currently
being pursued.

small.

As oil prices continue to rise and conventional energy resources face constraints, solar energy use can be expected to continue to rise--to 9-12 quads in the year 2000, based on projections of current trends. The potential exists for an even greater solar contribution by the year 2000 if the Federal government were to play a major role in encouraging further research and development, in reducing social, legal and financi barriers, and in assisting in the commercialization of solar technologi

I. GOVERNMENT'S OBJECTIVES

In July 1979 the President, based on recommendations from the Domestic Policy Review (DPR) of Solar Energy, established a national goal of providing 20 percent of our energy needs from solar and renewable energy sources (not including Geothermal) by the year 2000. The DPR concluded that this is roughly double the level of solar use which would occur in the absence of new government programs. Achievement of the goal will depend to a great extent on actions of State and local governments, business and the many individual decisions of consumers. The purpose in setting the goal was to establish certainty with respect to our national commitment and federal policy, to mobilize and coalesce the growing public interest in solar, to drive government programs and to challenge industry.

The Administration and the Congress have accelerated the solar option for a variety of reasons. Perhaps the most fundamental reason is the realization that over the next 100 years, the world will increasingly rely on renewable energy resources as fossil energy resources are depleted. As a nation, in the near term it will be necessary to provide ourselves with alternatives which can help to counteract the insecurities of foreign controlled oil supplies and cartel dictated energy prices.

When the President announced the 20 percent goal, he cited many benefit of solar and other renewable energy resources including pollution abatement, job creation, international trade opportunities, safety of the technologies, and anti-inflationary aspects. To realize these

*Geothermal energy, which was not included in the Domestic Policy Review of Solar Energy, is included in this broad interpretation of th term renewable energy resources. Geotherma is disc ssed at the end

Solar energy has two economic disadvantages that weaken its competitiveness: 1) there is often a high initial capital cost relative to investments in other technologies, and (2) the payback period for sola investments is generally longer than conventional investments (it take several years for the benefits of the low operating costs to outweigh the initial capital outlay). The chart at the end of this section gives the estimated costs of solar technologies and compares them to historic energy prices.

The comments in this section and the chart at the end, are based on th cost data developed by the Domestic Policy Review of Solar Energy (DPR). The cost figures have been updated to 1980 dollars and normal to barrels of oil equivalent. Accurately predicting the future costs of any energy source over the next 20 years is difficult. It should b recognized that these cost projections for solar may be low by as much as 50-100 percent. We are more certain of the probable costs of the technologies that are almost economic now. However, it is too early to tell which ones will be widely competitive with conventional sources.

Solar is already economically competitive with electricity for providi hot water, and with other fuels for a few specific process and space heat applications (passive solar and wood combustion, for example). Th time when competitiveness with oil may be achieved is highly uncertai but if current oil price trends continue, solar energy could possibly provide an economic alternative to oil for space conditioning and process heat in another 10 years. Solar thermal electric applications will likely require a longer time, perhaps into the next century. However, it is possible that wind will be competitive much earlier.

II. THE EXISTING PROGRAM

The present Federal Solar Program has focused primarily upon developi solar systems which will be competitive in the marketplace, with a secondary goal of overcoming "institutional" barriers (codes, standard financing, technical and non-technical information, and technical training, etc.).

A. COMMERCIALIZATION PROGRAM

DOE is already proceeding with the accelerated commercialization of four solar technologies (wood combustion, hot water, industrial

solar technologies.

8. RESEARCH AND DEVELOPMENT PROGRAM

The solar technology R&D program has been focused on overcoming techni problems and reducing cost. The FY79 budget request (prior to the DPR placed heavy emphasis on developing systems for providing hot water and space heating ($45 m), and generating electricity by wind turbines ($61 m), photovoltaics ($108 m) and solar thermal systems ($100 m) where knowledge about the problems is most advanced. Equipment to provide agricultural and industrial process heat ($11 m), biomass energy ($37 m), and ocean thermal power systems ($33 m) received relatively low funding in the FY79 budget.

III. GUIDANCE FROM THE DOMESTIC POLICY REVIEW

The Domestic Policy Review of Solar Energy, which culminated in the President's June 20, 1979, solar message, provided broad guideline as to future directions the federal solar program should take. The DPR achieved a broad consensus within the federal establishment on the future potential of solar energy and provided a preliminary estimate of the potential impacts of possible incentives which could be initiat by the Government. While the precise quantitative objectives appearin in the DPR documents are of general interest, the trends indicated and relative magnitude of the numbers are far more significant than the numbers themselves.

Based on the findings of the DPR, the national solar goal could be mos likely achieved by the following technology mix (shown in decending order of anticipated importance).

1. Biomass
2. Hydroelectric
3. Agricultural & Industrial Process Heat
4. Active Heating, Cooling & Hot Water
5. Wind
6. Photovoltaics
7. Passive Design
8. Solar Thermal Power
9. Ocean Systems

Biomass and hydroelectric together are expected to constitute about

in the year 2000. The most promising technologies are the direct burning of wood, liquid fuels from biomass, and biogas. Biomass technologies have not received a level of effort in the past commensurate with their energy potential. However, the FY81 budget placed greater emphasis on biomass as a result of a better understanding of the promise of liquid fuels, wood combustion, and gaseous fuel substitutes ($63.0 million). The FY82 budget should continue this trend.

To promote the use of gasohol, the Department will establish an Office of Alcohol Fuels under the AS/CSE. The Oepartment has set a "target" of producing at the rate of 10 percent of all unleaded gasoline blended with 10 percent ethanol during 1981, and 30 percent of all unleaded gasoline blended with 10 percent ethanol by the mid 1980s.

While the potential contribution of biomass is believed to be large, there is currently too little information on costs, environmental implications, effect on food production, etc. upon which to base further long run program tradeoff decisions. The analytical and experimental work necessary to provide this information is important and should provide results in the mid term if the full potential of deriving high quality fuels from biomass is to be realized.

B. HYDROELECTRIC

Hydropower is already the most fully developed renewable energy resourc Approximately 3 quads per year are now produced at primarily large-scal high-head facilities. The DPR projected that an increase of .5 to 1 quad of high-head (mostly large-scale) production is possible. While small hydro projects produce a negligible amount of power at the present time, the DPR set a target of .8 quads by the year 2000 from predominantly low-head facilities. Studies underway since the DPR suggest that these estimates could be low.

DOE's current hydropower efforts relate exclusively to small-scale projects. The long-range goal is to establish a small-scale hydroelect industry based on the rehabilitation and retrofitting of existing dams and the development of new projects.

The emphasis of the program is presently on feasibility studies. Priority should be given to activities aimed at making small-scale hydro projects a desirable private investment. In particular, this means more effort in reducing institutional barriers to obtaining

Three basic considerations should guide the preparation of the 5-year program strategy.

- The Department should give high priority in the next five years to commercialization and technology development activities for those solar technologies which appear to be capable of providing delivered energy at a level competitive with alternative sources priced at their marginal costs.

- The Department's priorities for the rest of the solar technologies should be guided by the size of any additional premium (on a per barrel of oil equivalent basis) which would be necessary to bring each technology on line. Decisions about the pace of commercialization and additional R&D will be made on the basis of the estimated additional premium required and its justificatior solar technologies should benefit from higher subsidies than an oil import reduction premium alone because of positive environmental and employment effects.

- As the Solar DPR and several other studies have indicated, the Department's R&D efforts in the solar area should concentrate more heavily on the development of near-term technologies for producing heat and fuels, community scale applications and low-cost solar applications rather than on technologies to produce electricity from large centralized facilities. The relative emphasis in the R&D program between the solar technologies should be guided by an understanding of the end use sectors which is being gained from the commercialization program and other sources. The basic research on advanced renewable energy systems which is crucial to achieving solar's long-term potential of contributing to the Nation's energy supply is discussed in Section G.

V. SOLAR PROGRAMS

The DPR recommendations and the planning principles provide the general guidance for solar systems planning. The specific choices of activities related to each technology must be based on a number of factors includin echnical readiness, economic competitiveness, environmental accepta- ility, and manufacturing capacity. The program office should develop interim goals for 1985 and 1990 for each technology based on end use req uirem nts and the probable cost of delive ed energy for each app ica-

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Overcom g t lity ctance to purchase excess power is important.

There should also be more attention paid to technical and systems information. Direct federal R&D expenditures are probably less importa in this area than evaluating both foreign and domestic private develop efforts and in making the resulting assessments readily and widely available.

C. AGRICULTURAL AND INDUSTRIAL PROCESS HEAT (AIPH)

According to the Domestic Policy Review of Solar Energy, approximately 2.6 quads of conventional energy can be displaced by the year 2000 in the industrial and agricultural sectors. This is more than 10 percent of the President's goal, and is based upon significant efforts among state and local governments and the private sector. This estimate als reflects recent trends that favor industrial use of solar energy as a means of complying with environmental regulations.

AIPH consists of a variety of technologies suitable for different temperature ranges and end-use applications. Some of these technologi are in the early stages of commercial use now (low and intermediate temperature collectors, alcohol and methane production on farms), but others (high temperature collectors, on-site wind, some feedstocks) ar expected to remain expensive, compared to currently priced conventiona fuels, for at least several years.

Rapid commercialization of AIPH equipment is dependent upon reductions in prices more than upon further product research. Both the Administr tion and the Congress have proposed additional investment tax credits for AIPH equipment. The level and duration of these credits will be important to the cost-effectiveness, and thus the utilization of solar heat in these sectors.

One of the most serious barriers to achieving the quad goal envisioned in the DPR, will be the capital investment necessary to produce the billions of square feet of collectors necessary to meet the goal.

D. ACTIVE HEATING AND COOLING

Residential and commercial solar space conditioning and hot water are expected to contribute 2.0 quads toward meeting the national goal. Commercialization of these technologies has begun with active hot wate systems. It is anticipated that by the early 1990s, active space heating systems will become dominant and will produce about twice as much energy as hot water systems by 200_. Past DOE budgets have al[illegible]

development is required on performance, reliability and durability of present and advanced systems and on achieving optimum combinations of components for various climatic regions, building types and market sectors.

The program should continue to address how well solar heating systems can achieve compatibility with load and pricing systems of utilities. This includes consideration of off-peak pricing structures and use of off-peak storage units.

Finally, the question of cost-effective retrofit applications of solar heating systems is crucial to achieving the national goals. The strategy for combined solar/heat pump systems and combined solar heating and cooling systems, both of which are less mature technologies, is to emphasize R&D in the near term, with emphasis shifting to market development for combined solar/heat pumps in 1981-82 and to combined solar heating and cooling in the 1983-85 time period.

E. WIND

Wind can provide energy in the form of electricity or mechanical power. Wind power has existed for centuries, but recent developments in the aerospace industry have increased its potential as a reliable source of domestic energy. The Solar DPR estimated that the potential exists to displace nearly 1.7 quads of energy by the year 2000. This goal implies the wide use of wind machines in all parts of the country where sufficient wind exists, and it implies further developments in the energy storage technology to render wind a more reliable energy source.

To date DOE's wind program has been heavily oriented toward R&D ($63.4 million in FY80 compared to only $2.8 million for the commercialization of small wind machines). DOE has concentrated on large horizontal axis machines to generate electricity for power grids. Private firms are becoming active in the small machine markets. Early DOE program studies identified the major market for wind as the small utilities and utilities that have a hydroelectric capacity which could act as "storage to be used when wind is not available. In addition to utilizing only single machines, there is theoretical work which suggests there are advantages to grouping machines into "wind farms." Such an arrangement would increase the value of wind equipment to the utility.

The photovoltaic technology offers the hope that solar energy can be harnessed cheaply to produce electricity. However, substantial technological development and significant cost reductions must be achieved for photovoltaics to play a significant role by the year 2000. They will not contribute a significant amount of energy within the next decade; however, the Solar DPR estimates that 1 quad of conventional fuels could be displaced by 2000.

Whether that target is realistic will depend in large part upon a continuation of the technological breakthroughs that have brought the cost of photovoltaic arrays and systems down to current levels and the level of funding of the federal program. Current systems costs are estimated at $15-30/peak watt (Wp), which corresponds to a cost of electricity of $.70-$1.40 per kwh. The current cost of conventional electricity from coal or nuclear power plants range from $.02-$.05 per kwh.

G. PASSIVE SOLAR

Passive solar space heating can be expected to contribute about one quad of energy by the year 2000. This could be doubled by effectively implementing the solar utilization programs in cities and towns (SUNACT) Annual savings of 30-80 percent for residential buildings have been demonstrated throughout the U.S. in successful applications of passive solar heated and cooled buildings. Passive solar has only received DOE funding since 1978.

The most promising passive solar application for commercialization now is space heating for new, single family residences. This application is already economical and should achieve appreciable market penetration if the more significant barriers to its use such as the lack of generally available credible cost information, marketable designs, financial incentives, and building industry awareness and acceptance are removed.

The program to date has concentrated on passive solar heating for new, single-family residences. Future passive solar RD&D should encompass space conditioning for multi-family residences, commercial buildings and light industrial areas, including retrofits of all types of existing buildings.

H. SOLAR THERMAL POWER SYSTEMS

year 2000. If significant reductions in costs can be achieved and appropriate federal incentives put in place, this goal could be met as early as 1990.

Solar thermal power systems encompass four technologies -- central receivers, parabolic troughs, parabolic dishes, and spherical bowls -- and five potential markets -- central station utility (stand alone and repowering), industrial process heat, remote applications, total energy systems, and community electric systems. Of the four technolog only parabolic troughs for industrial process heat are considered near commercial readiness. The remainder will require substantial research and technology development to bring down costs, although no major breakthroughs appear necessary.

The heart of the solar thermal power program has been, and still is, the central receiver program, which is aimed at producing electricity for the utility market. After much controversy and reconsideration, the Barstow facility appears to be ready to proceed to operation in 1981, although cost overruns seem likely. The main decision facing this program is the size and timing of a demonstration program to follow Barstow. Recent studies by SERI indicate that the value to a utility of a central receiver system will exceed the projected costs of such systems in the late 1980s.

I. OCEAN ENERGY SYSTEMS

Component testing and feasibility study should lead to a decision within 1-2 years on whether or not to proceed further with the Ocean Thermal Energy Conversion (OTEC) concept. Within 3 to 5 years, ongoing analysis and experimentation with other types of ocean energy systems, including waves, tides, and ocean currents, should be able to provide the necessary information on which to decide the advisability of proceeding further with development of the technologies. Private sector experimentation with these systems is already underway.

J. GEOTHERMAL

The major objectives of the geothermal program are: (1) to support the commercialization of hydrothermal resources in the near term (1985) and to encourage their continued rapid growth in the mid-term (2000) and beyond; (2) to evaluate the potential for economic recoverability of methane, thermal, and hydraulic energy from geopressured resources

2000. In addition, it is anticipated that commercial production of geopressured methane may amount to as much as 0.02 quad/year by 1985 and 3 quads by 2000.

In general, hydrothermal resources require emphasis on resource definition, reservoir reliability, market penetration and barrier analyses, as well as on financial incentives. Moderate temperature hydrothermal resources, however, require technological improvements to make electric power production economical; and low-temperature resources require federal resource and reservoir definition efforts, in cooperation with the States, in order to make these resources available for direct heat applications. The hydrothermal program should be thoroughly re-evaluat at this critical juncture as commercialization begins.

The principal emphasis on geopressured resources is on resource and reservoir definition, so as to make possible a reliable estimate of the cost of recovery of the thermal, hydraulic, and (most important) methane energy. This emphasis on resource and reservoir assessment should be continued, in order to eliminate the critical unknowns in calculating the economics of resource extraction.

The long-term energy future is inherently uncertain. As noted in the overview, it is difficult to predict with confidence what future energy prices may be. It is difficult also to know what the global, national, or local reliability of supply may be, at any price. This uncertainty seriously undermines the ability of individuals and firms to plan for their own futures. It also undermines the confidence that public officials and their constituents can have about the nation's future security and the future health of our economy.

Research and development (R&D) is the basic tool available to reduce these serious uncertainties and improve our grip on the future. R&D, properly focused and effectively pursued, can substantially improve our knowledge of resources. It can also significantly enhance our understanding of and ability to deploy means for converting energy resources into useful energy forms and ultimately into services that people value (e.g., heat, light, motion). R&D can improve our ability to control energy flows, and to match supplies with demands. It thus can increase the performance of critical services (e.g., manufacturing) for which the price of energy matters less than the predictability and reliability of supply.

R&D serves three basic objectives:

- Open new opportunities by discovering or creating ideas, things, or procedures not now known--e.g., by learning how to tap resources that cannot now be exploited economically.

- Improve the cost and performance of energy use and supply by developing advanced technologies from existing scientific and technical ideas; and

- Reduce critical uncertainties about the cost and performance of technologies already in development, to accelerate and improve the private sector's ability to put into use the most promising newer technologies;

The Federal role in R&D is an historic one, dating back to the land grant universities in the mid-1800s and the formation of the Bureau of Mines, the Bureau of Standards, etc., in the early 1900s. Federal R&D expanded especially rapidly in all fields--including energy--*during* and following Wo d War II. a a onal aders u d s ie t adva ce

- Private discount rates often are so high that investments with long lead-times appear unattractive. This is the case unless the potential returns from the investments (or the costs of not making them, e.g., going out of business) are large enough to offset the discounting. The nation, however, must endure and must be concerned with making secure the heritage it provides subsequent generations. (This argument underlies much environmental law.) Hence, the Federal Government must ensure the national heritage by undertaking critical activities with long lead-times so that the results will be available when they are needed.

Hundreds of analyses to quantify the benefits of investment in R&D have been made. Virtually all find a posteriori quantification possible, but a priori estimation very difficult. The outcomes of R&D are often even more uncertain than the events R&D seeks to help control. Also, in well-run R&D programs, substantial cross-fertilization occurs; energy conservation R&D by itself would not have been likely to develop microprocessors for end-use control, but space, defense, and industrial electronics R&D did. Similarly, R&D on fast-growing biomass for energy may turn out to have a greater impact on food or fiber supplies--thus helping the nation, even if not in the way originally intended.

II. STRUCTURE

This guidance addresses three broad areas of DOE's advanced technology R&D:

- Advanced technology development for conservation and for renewable energy sources (and for selected advanced technologies using other resources);

- Basic research in energy sciences; and

- R&D on nuclear fusion energy.

These programs are predominantly the responsibility of the Assistant Secretary for Conservation and Solar Energy, the Director of Energy Research, and the Assistant Secretary for Defense Programs. A few are the responsibility of the Assistant Secretary for Fossil Energy and the Assistant Secretary for Nuclear Energy.

opens important options. In the future, more emphasis will need to placed on resources not being exploited substantially today. This emphasis follows from consideration of available resources and the n to shift to renewable and inexhaustible resources in the long-term future.

The guidance seeks to elicit program plans responsive to future need even though these needs can only be perceived imperfectly at present It does not identify all trends important to each program. Instead, expects that the five-year program plans for each program element wi discuss other appropriate trends and developments in the issue secti of their submissions.

A. INCREASING CONSERVATION

The current program uses a "targets of opportunity" approach. Speci technologies are chosen. Demonstrations are designed to show their efficacy. Then DOE tries to encourage the technology's transfer int broad usage by information dissemination and by example. This strat emphasizes technologies existing now, to meet immediate and obvious needs.

However, it does not address systematically the need for improvement in our fundamental knowledge that could result in great long-term benefits. With technological advances substantially increased energ productivity is possible, given the same supplies of energy. Theref we emphasize the need for longer-term research necessary to achieve this overall increased productivity. For example, DOE advanced technology R&D programs should emphasize study of the following basi areas:

- Improved combustion efficiency in several temperature ranges;

- Utilization of what is now wasted heat through better low temperature-difference heat exchangers and more efficient energy conversion from low-grade heat (e.g., significantly improved heat pumps);

- Development of high temperature materials to help achieve higher efficiencies from processes dependent on thermodynamic cycles; and

for example. Modest efforts have already begun to improve home furnace efficiencies to 60 and 70 percent; comparable improvements appear possible and likely with R&D in many other areas. The potential payoff is very high, and the required R&D relatively moderate in cost.

Similarly, waste heat from utilities represents a resource exceeding 14 quads per year; waste heat from industry at least another 6 quads per year. Such a vast resource, albeit one of low thermodynamic quality, warrants a much larger R&D effort than it now receives.

In addition, for conservation, we suggest emphasizing R&D and commercia ization activities that can substantially and quickly improve the efficiency of all energy-intensive industrial processes. The most energy efficient processes now feasible, for example, show that energy consumption per unit of output could be reduced 50 percent within a generation.

B. INCREASING RELIANCE ON RENEWABLES

Countless studies show abundant renewable resources not now used--over 3,000 quads per year of potentially usable sunshine on the continental U.S., for example. Technologies to use these resources--wind, solar, biomass, etc.--tend to be economic in smaller sizes than today's large energy sources. In fact, for some applications, the rapidly increasing costs associated with transporting diffuse resources (as all renewables are) to a central location would effectively limit the size of installa The dispersed nature of these technologies means that issues that are not overly important now may hinder the use and deployment of renewable resources.

The following topics need more R&D emphasis:

- The problems of operating and controlling systems incorporating thousands of small electric plants, instead of just several large electric generating plants;

- The problems of using generating sources whose output is intermittent in nature (that is, not controllable) instead of generators whose output can be controlled closely.

In addition, engineering and institutional effort is needed to stimulat systems that combine dispersed preprocessing of renewable materials

year. The vision of an "all electric" society once advocated has not been heard recently. Electricity's share of year 2000 energy at poin of use is now expected to be less than one-fourth. Several studies (e.g., the Inexhaustible Energy Resources Study conducted by ERDA in 1976-1977) have emphasized the imbalance in DOE's long-term R&D between technologies that produce electricity and those that produce other energy forms.

Long term DOE programs currently directed toward producing electricit include those developing advanced converter and breeder fission react advanced coal-to-electricity technologies (atmospheric and pressurize fluidized beds, molten carbonate fuel cells, combined-cycle systems with advanced high-temperature turbines, magnetohydrodynamics), magne confinement fusion, inertial confinement fusion, solar thermal electr wind machines, ocean thermal energy conversion, and photovoltaics. The long-term technologies directed toward other energy forms are far fewer. These include: synthetic fuels (coal gasification and liquefac oil shale, biomass fuels); solar heating, cooling, and hot water; sma atmospheric fluidized beds for process heat; solar process heat; and direct burning of biomass.

Substantially greater emphasis over the five-year period should be pl on non-electric technologies and applications.

IV. BASIC ENERGY SCIENCES

The Basic Energy Sciences programs aim to meet the need for a knowled base. The programs strive to provide long-term leverage--better under standing of basic natural phenomena related to energy, and creation of new capabilities on which to build energy applications. For such programs, it is a matter of many decades to widespread application. The results are fundamentally unpredictable and cannot be scheduled rigidly, and the nature of the results can completely change the economic balance from that estimated a priori. They also can provide short-term leverage--an inventory of insight and techniques that can b brought to bear on current development problems as application orient programs work to advance the state-of-the-art.

Since these programs work with a process that is very long term and fundamentally unpredictable, conventional engineering development rul for assigning budget resources and priority of emphasis do not apply. For allocation of resources to basic research there is no univer al

functions without commensurate increases in funds--it is now 5 percen of the energy development budget, which is too low.

The balance of the program is also not optimum. It needs increased emphasis on:

- Engineering sciences--basic techniques, instrumentation;

- Social sciences--major barriers to energy policy implementati and

- Biological systems (life sciences)--application to energy production and use.

There have been many assessments and analyses of basic energy science and other DOE research activities over recent years. Some are still progress. A summary assessment is needed to support the five-year plan. This work should be led by OER. It should include a plan to initiate a formal program of energy-related social science research.

V. FUSION

The DOE fusion effort comprises two separately managed programs: Magnetic Confinement (MFE) and Inertial Confinement (ICF). The energ applications development of both programs are covered by a September 1978 DOE policy statement.* The long range nature of the research an development (several decades) required to develop fusion energy manda virtually total Federal sponsorship. In essence, the strategy of bot programs is systematically to generate an adequate basis of scientifi understanding and technological capability, thus to proceed to develo ment and engineering of applied energy systems. From the ICF program there also is a somewhat nearer term potential for nonenergy-producin military applications. For both programs, the strategy currently requires broad approaches that ensure pursuit of several viable optio

The present central task of both programs is to establish and demonstrate a scientific and technological basis adequate to proceed to th engineering phase. A laboratory demonstration of energy breakeven (a much energy out of a fusion reaction as was put in to achieve it) is key milestone. Although such controlled reaction conditions have not been achieved, good progress is being made.

decision to move into the engineering development phase via to build a major ($1 to $2 billion) engineering test facilit critical consideration is the nature and extent of the scien and technological capability which will be available to just commitment. Before making that commitment, a thorough techn assessment (including environmental, health and safety measu MFE program is needed. Such an assessment should be led by of Energy Research and should recommend future program direc

The ICF program is now concentrating on the basic physics of source (driver) interaction with fusion fuel targets, from w achieve a demonstration of scientific breakeven. From the l glass laser technology, military applications are possible. various assessments indicate that glass lasers are not likel good for energy production. Therefore, it is important to a develop alternative drivers for energy applications. In add observing the need for research into driver/target physics, Committee report (recently prepared by a blue-ribbon panel) need for a balanced program in driver development. This shou reflected in the ICF five-year plan.

The coupling with military (defense) programs makes the ICF potentially more important to Defense Programs in the event comprehensive test ban. Planning is needed to prepare for s event. Defense Programs should lead, with PE participation, in detail the role of the ICF program in the event of a test as well as the impact of a test ban on the ICF program.

Conservation is the most immediate and cost effective means to deal with the energy problem by reducing the need for oil imports; mitigati the impact of rising oil prices; increasing the efficiency of the U.S. economy; limiting the transfer of wealth to oil producing states and from consumers to producers of energy; and, extending the availability of dwindling fossil fuels. It also promotes protection of the environ- ment by minimizing pollution. Unfortunately, the meaning of "conserva- tion" as used by government policy makers and as perceived by the 220-odd million decision-makers in the country differs substantially. There is ample opportunity in the U.S. economy for more efficient use of energy and avoidance of waste with a resulting increase in producti and general economic efficiency. Consumers often perceive conservation as radically changed lifestyles and deprivation, possibly to the benefit of energy suppliers as conventional fuel prices rise. This perception is encouraged when "conservation" is linked to some of the more draconian measures envisaged to deal with supply interruption crises (e.g., rationing or dramatic fuel price increases through excis taxes); these are curtailment measures and are discussed elsewhere in the guidance under Contingency Planning. In any event, the difference in perception impedes the development of a coherent, and widely accept national conservation policy. The purpose of this section is to revie the opportunities for conservation and the impediments to effective actions by Federal, state and local governments and consumers. Out of this review come priorities to be followed to achieve sharper forms of federal conservation policies and actions.

I. OPPORTUNITIES FOR CONSERVATION

Macroeconomic comparisons of energy consumption in industrial countrie indicate room for substantial economies in North America:[1]

Country	Energy Consumption Per Capita (tons of oil equivalent)
USA	8.3
France	3.5
W. Germany	4.5
Sweden	6.1

when comparisons are made between the efficiencies of new, availa
energy-consuming machines and equipment in the United States and of those in use; on average the existing capital stock in the U.S. appears to be half as efficient as it might be.

Demand reduction is clearly an energy "source" and conservation investments can and should be compared with alternative fuels. As th potential for demand reduction with existing technology is enormous, and conservation investments provide long term relief from fuel requ ments (because of the long life of capital equipment and buildings), conservation investments for a wide variety of end uses compare very favorably with alternative fuel options on a cost/ benefit basis. T is true for some investments (e.g., home insulation, heat pumps, industrial co-generation) even at prices for imported oil <u>below</u> the current OPEC price of $30 per barrel. Addition of a premium to the o import price forecasts to allow for environmental and national secur benefits makes a host of additional conservation investments look ve desirable from the national and consumer standpoints.

II. <u>RECENT CONSERVATION TRENDS</u>

Market response to the competitive nature of conservation measures and rising real energy prices has been encouraging. The rate at whi energy consumption has increased in the U.S. economy has fallen well behind the rate of increase of GNP in recent years. The reasons for this decline are not perfectly understood and projections of a major departure from the post World War II historic trend are subject to great uncertainty.

<u>Ratio of Growth of Energy Consumption to Growth of GNP</u>
<u>(Avg. Growth Rate-Energy/Avg. Growth Rate-GNP)</u>

1946-1950	1950-1966	1966-1970	1970-1978 a/
.94	.87	1.70	.61

a/ detail:

1973	60.4
1974	59.3
1975	59.3
1976	58.6
1977	57.4
1978	56.4

and operations, and some shifts in the overall production base away from energy-intensive sub-sectors in manufacturing and from manufacturing to services. There are significant shifts in consumer behavior that have been documented in 1978 and 1979 specifically in motor vehicle purchases and use and in residential fuel switching and insulation. The real increases in prices that have been experienced along with actual physical shortages have been more severe than before. However, there has not been adequate time to determine that the shift in behavior is permanent. Although we suspect the recent decline may be, in part, due to conservation investments (as opposed to forced response through regulation and simple adjustments to thermostat settings), we are not sure. We do know there remain substantial political, social, and institutional barriers to be overcome before substantial further increases in energy economies can be realized.

III. BARRIERS TO ACCELERATED CONSERVATION

The decentralized nature of most conservation decisions dictates substantial reliance on market mechanisms; if the market does not respond to the economic desirability of conservation investments (as mentioned earlier), it is because of market distortions or inadequacies of market institutions some of which can be corrected by direct government action.

Market response is impeded by:

- uncertainty about future energy prices
- uncertainty about investment costs
- doubts about potential savings from conservation investments due to:
    - present energy prices
    - lack of confidence in technology
- uncertainty about environmental effects, e.g., diesel engines
- lack of access to capital
- lack of choices because of:
    - high proportion of renters among residents in less energy efficient dwellings
    - uneven distribution of wealth between households
    - unavailability of equipment and materials

individual (or corporation) to justify actions
-uncertainty about government's intentions

The federal government's conservation policies and programs must address all of these market barriers in collaboration with state and local governments. The probable speed of market response to conservation is a major unknown in the development of a coherent national conservation strategy.

IV. GOVERNMENT OBJECTIVES

The overall objective is to encourage the adoption by the economy of cost-effective (in comparison with other fuel alternatives) conservation measures as rapidly as possible. The principal means to attain this objective is to use to the maximum extent existing market mechanisms using supplementary Federal actions only where market response is impeded by structural problems such as limited access to capital, minimal investment incentives (e.g. landlord/tenant relationship), incorrect signals including information, sluggish reaction times, or inability to recognize broader national benefits.

"Maximum speed" implies enhanced Federal attention to conservation and careful evaluation of programs and other actions to see if federal resources and actions are properly focused and are of the appropriate magnitudes. Deregulation of energy prices to bring them to their true replacement costs is one, but not necessarily the fastest, way to induce market response. In the absence of rapid deregulation, the quickest market response is likely to come from a combination of aggressive marketing and information programs and financial incentives. Federal direct action in employing conservation measures in its own buildings and upping mileage standards in its own vehicle fleet should also bear near-term results as well as have a positive effect on the nation. Regulation can take longer and should be used only in particular circumstances, e.g., where producers and builders are reluctant to move to higher efficiency, known technology because of poor market signals and where there are long lead times for conversion of product lines; in the case of buildings, their long lifetimes argue for regulation of codes to assure high energy efficiency. Federally funded R&D by its nature tends to be long term. Institutional barriers, production lead times, limited early market penetration rates and the research itself all add up to five to ten year lead times before significant conservation effects are possible. These programs have to pass other tests associat

studies and in the interest of assessing the possible results of
a Federal conservation strategy involving enhanced Federal action for conservation and reliance on available technology through 1990, projections of consumption by end-use in that year were done. For a real GNP growth rate of 3.1 percent, the in-house analysis shows the following possible energy savings in 1990 in comparison with actual consumption in 1978 and a projection of "business as usual" practices:

U.S. Energy Consumption (Quads)

	Residential/ Commercial	Industrial	Transportation	Tota
1978 Consumption	28.5	30.0	20.6	78
1990 No Change Path	43	47	24	114
1990 Possible	30	38	18	86
% Savings	30%	20%	25%	25

These savings look attainable, especially since they do not entail major technological breakthroughs. Achievement of this level of energy savings, however, does entail a much sharper focus of Federal action than has been the case to date. Out strategy is to treat these savings as minimums to be attained, and hopefully exceeded, through careful and discrete application of a range of Federal actions all designed to stimulate market response.

To arrive at the desired focus of Federal action we have to review the end user investment oriented programs and put them in order of desirabi from an economic efficiency standpoint. The "best" programs would be those aimed at stimulating investments with benefit/cost ratios greater than one at current fuel prices; the next "best" would be those with ra greater than one at replacement cost prices for fuels, and the remainin programs can be tested against the level of premium (over replacement cost) for environmental and security factors which would bring the ratios to one.

The policy implications of a cost-effectiveness ranking must be coupled with a recognition of the relative urgency of response. Americans living near or below the poverty level do not have discretionary income to redirect towards higher energy prices or towards major conservation investments. Although the energy savings may not be as high as those available from other conservation investments, the gover en as a

would be the difference between the price seen by the consumer and the replacement cost price plus premium.

Other, non-investment oriented conservation programs have to be examin in light of our ability to go through the prioritizing steps above. W may decide to spend a lot more for R&D if our knowledge about costs an benefits is too limited. Our marketing and information outreach programs have to be derived from such an approach.

It will not be easy to complete this prioritizing with a high level of confidence as the following short review of present programs signals. There are large uncertainties about the costs and benefits of conservation programs--the direct cost to consumers of existing technology are quite certain but the indirect costs of getting them available in the market reliably are not.

V. PRESENT DOE PROGRAM ACTIVITY

DOE will obligate approximately $870 million and spend approximately $759 million in FY80. Of this, $215 million will be for RD&D, $402 million for grants for retrofit of buildings, $160 million for general assistance to state and local governments, and $1 million for the Federal Energy Management Program. Most of the remainder is for information and outreach.

The support for state and local governments recognizes their essential role in implementing/enforcing Federal assistance and regulatory programs.

Grants for physical improvements to buildings are limited to those, i.e., schools, hospitals, local public buildings and low income househ who are not directly responsive to the market.

Research, development and demonstration funds are used for a large number of projects, some of which are cost shared with industry. However, almost half the total supports two transportation projects mandated by statute, Vehicle Propulsion and Electric and Hybrid Vehicl

A growing number of regulatory programs which require changes in the design of capital stock are being developed and implemented. Thos with the greatest energy saving potential, i.e., Building Energy Performance, appliance, fuel economy and possible future pumps and motors standards, also have the greatest potential for eco omi .

and analysis in these areas; additional support is warranted.

The Federal Government has been in the conservation business for a very short time (in comparison with its involvement in the production of competing fuels). Thus the present set of tools being employed (grants, loans, loan guarantees, tax credits, direct and indirect subsidies, R&D and regulations) are almost experimental. In addition the substantial marketing and information outreach programs (13 agenc spending $270 million in FY80) are transmitting messages which are incomplete, uncertain as to market audience, and occasionally contrad (particularly when they refer to the ease of implementation of conservation measures and their relative economic merits). This is hardl surprising. The Government is in the conservation business but doesn' yet fully understand the market for conservation; data are either not available or poorly correlated, making market response prediction cha at best. Market research, and evaluation wherever enough operational experience is present should be a top priority for Federal, state and local government and private programs.

In evaluating those on-going programs, a more strategic approach must be taken which recognizes:

- the greatly heightened national sense of urgency about reduc imports and stabilizing energy prices in the near future;
- the size and significance of the savings opportunity as refl in a realistic set of energy savings estimates;
- the probability of successfully implementing the program; an
- the complementarity of the program with other major energy s programs and environmental objectives.

VI. NEAR-TERM RESULTS OF DOE AND SELECTED OTHER FEDERAL PROGRAMS

Present DOE authorizations and appropriations permit the expenditure $3.4 billion over the next four years. Some insights to guide future DOE program development and other Federal actions are emerging from other existing programs.

A. TRANSPORTATION (26% OF END-USE CONSUMPTION)

Regulation of auto efficiency standards is now taking effect and results in decreased fuel consumption are evident. Since automobiles and trucks consume amounts of fuel equivalent to all of U.S. oil

Preliminary analysis indicates much higher energy efficiency per ton-mile for freight and per passenger mile in the railroad subsector compared with alternative modes (other than barges) over long distances Nevertheless, a continuing shift away from rail in favor of road and air indicates a need to examine rail rates to see if energy economy is being fairly reflected to possibly offset perceived greater convenience and reliability in other modes.

Energy efficiency can be increased by revising existing regulations governing the hauling of freight by trucks; preliminary analysis indicates that the current regulations encourage empty or partially-loa hauls and circuitous routing.

Studies of the points of transfer of goods and people from one mode of transport to another (modal interface) signal great potential for energy savings in both long distances and intracity transport. Also, proper trip planning (i.e., consolidation of trips, use of mass transit), proper automobile maintenance, ridesharing and the selection of energy efficient vehicles provide opportunities for reducing energy consumption in the transportation sector.

A re-evaluation of Federal R&D for new engines and new types of vehicle appears to be warranted to determine if these programs best support the strategy of primary reliance on market forces and fuel economy standarc The present R&D programs should be carefully reviewed to see if a larger share of them should not be left to the industry to manage and fund or whether new directions should be taken, recognizing that legisl changes would be required. One fruitful area for increased Federal R&D is in diesel engine emissions. This highly focused kind of research, if done quickly and well, could permit the shifting of propulsion towards a more efficient engine much sooner than is now likely because of uncertainty about environmental effects and possible action, e.g. EPA particulate standards.

B. INDUSTRY (38% OF END USE CONSUMPTION)

The present program of tax credits on industrial conservation investmer has produced very modest response. Although it is perhaps too early to draw any conclusions about the size and appropriateness of the tax credit as a tool of public policy, we are aware of several characterist of industry which indicate that the credit is unlikely to stimulate

-energy saving investment decisions tend to be subject to very high rate of return criteria (on the order of 30% return on investment) to reflect industry's high degree of risk apprehension in the face of uncertainties about future fuel prices and possible government action; tax credits of much larger magnitude would be needed to make such projects look viable in the face of the absence of risk-reducing policy action (such as energy price deregulation); and

-co-generation projects suffer from the same problems plus uncertainty about the supply of fuel for existing technologies (most systems on the market are oil or gas fired) and about the possible earnings from sell-back electricity to the grids (due to regulation of public utilities).

RD&D can make advanced technology and processes more attractive to industry by providing information and reducing risk. The program is three years old and has produced one project which is represented in the market by 13 applications which cumulatively save .0018 quads per year. Current RD&D concentrates on technology development, yet in some areas, including co-generation, institutional and behavioral barriers are the most significant hurdles.

Detailed analysis of industrial behavior down to and inside various sub-sectors is required. This analysis will support an improved assessment of which Federal policy tools to apply in parts of the sector.

C. RESIDENTIAL/COMMERCIAL (36% OF END USE CONSUMPTION)

A variety of programs (Weatherization, Community Systems, State Energy Planning, Energy Extension Service) have been underway long enough for an assessment of their actual and likely results to be made. These assessments, some of which are on-going, should focus on determinin the energy savings stimulated by these programs.

We do know that residential conservation could be accelerated substantia over the response price alone stimulates. Early study results suggest four types of problems which inhibit consumer response:

-inadequate and/or inaccurate information on o ortunities

Building Energy and Appliances, have the highest potential for long term savings. Design research indicates savings on the order of 50% in buildings are possible. Research and development on commercializing technology components and on implementation issues is essential to ensure state and local cooperation and construction compliance and must be timed to compliment performance standard outputs. Without adequate research support BEPS could be a complication of the market, instead of a correction.

In the next few years, retrofit will contribute significant energy savings particularly from investments made by homeowners in upgrading their home's thermal shell. In addition to ensuring that the Residenti[al] Conservation Service and legislation which well provide subsidized loans are implemented effectively, work needs to be done with both the conservation products industry and with consumers to insure consumer protection.

Commercial buildings seem to respond much faster to current market signals than any other sector, reflecting perhaps high energy content of operating costs and better information. Slowest to respond are buildings owned by non-profit organizations and government. Since government is less affected by the market and is usually bound by annual budgeting which discriminates against operational efficiency alternatives, more direct assistance and regulation is appropriate. The Federal government could improve its image immeasurably by taking more aggressive action on its own stock of buildings.

New appliance minimum efficiency standards and labelling will remove some of the uncertainty about their purchase, as with autos. Informati[on] backed up by R&D on consumer preference and householder response plus, perhaps, some financial assistance where market sources are not working would appear to be the next set of tools to employ to accelerate residential retrofit. Market research should, incidentally, shed some light on the need for and likely response to federal financial incentiv[es] as we do not know how much is enough.

VII GUIDANCE FOR AN ANALYTIC APPROACH TO THE FY82 BUDGET AND 5 YEAR PROGRAMS

- Deregulation of prices of fuels is underway but will not in itself bring about execution of a conservation strategy based on maximum use of existing technology and development of new

-Since the ordering of programs and the focus of the tools depends on incomplete knowledge of probable market response, we may wish to intensify market research to give higher assurance that the conservation "packages" are properly oriented towards the end-user.

-Information outreach programs should be evaluated in the light of the steps above; they should be tested to see if they clearly identify simple, obtainable conservation "packages" including the sources of supply, installation, maintenance and finance.

-Basic conservation R&D should be examined in light of the guidance in Section G, Advanced Technology R&D.

-Hardware R&D programs should be reexamined and ranked considering the following general criteria:

1. Energy saving potential as determined by application of the first and second laws of thermodynamics
2. Readiness for commercialization
3. Market penetration estimate which specifically accounts (quantitatively and qualitatively) for non-technological barriers to penetration
4. Probability of success estimate considering the breakthrough(s) required
5. Complimentarity with other projects/programs aimed at the same conservation target of opportunity
6. Lack of private sector interest which differentiates between ability to undertake the research and lack of confidence in utility of its results

The Electric utility industry is the only discrete energy sector isolated for consideration in this guidance document. This is a result of the industry's unique characteristics that cut across fuel types and energy technologies. Additionally, this industry defies categorization as either an energy demand or supply sector. Its primary factor input of production is energy (coal, uranium, oil and gas) and its only product is also energy (electricity). Additionally, the ownership and regulation of the industry make it a key target for analysis, particularly with regard to national energy policy.

I. KEY FEDERAL OBJECTIVES

A. ADEQUATE AND RELIABLE BULK POWER SUPPLY

An overarching objective of Federal energy policy must be the assurance of an adequate and reliable supply of electric power both in the near term and the long term. With the increasing uncertainty associated with electric load forecasting, nuclear power, environment considerations and security of fuel supplies, it is becoming more difficult to plan future generation systems with sustained levels of assurance that they will be able to provide adequate service to the economy. To an increasing extent, "emergency preparedness" will become a key measure on the adequacy of future electric supply systems. In particular, the ability to withstand fuel supply interruptions will be a measure of system integrity.

Federal policy in this area is not as coordinated as it should be. Efforts such as the National Power Grid Analysis, establishment of emergency whelling tariffs, and development of future technologies will all potentially serve to enhance overall electric system reliability. However, overall Federal coordination of these efforts for the express purpose of optimizing the security of electrical power supplies does not exist. Most of this authority resides at the State level along with the overall control of the rate-setting and financial condition of the industry.

B. OIL IMPORT REDUCTION

Consistent with national energy policy, the key long-term objective o Fede enera icv in the electric utility sector is to

dependence on foreign imported oil, oil and gas a/ used by utilities as a boiler fuel should be viewed as a prime target.

The opportunity for reducing utility consumption of oil and gas includes (1) displacing existing oil-fired capacity by accelerating the construction of new coal, nuclear, or other generating facilities, (2) converting some existing facilities to coal or coal-based fuels (solvent refined coal, coal/oil or coal/water mixtures, etc.), and (3) less capital intensive alternatives such as conservation rate design, and load management. Not only are many of these technologies and approaches proven "on-the-shelf" options which can be called on immediately, but at forecasted oil prices, also offer economic advantages (i.e., lower electricity prices).

With the increasing price differentials between oil and coal (or nuclear fuel), more and more of the existing oil capacity is becoming economically obsolete and should be replaced by new nuclear or coal-fired capacity. This circumstance arises when the fuel costs alone of an existing oil-fired boiler exceeds the fuel plus capital cost of a new non-oil-fired boiler (on a discounted basis).

This relationship highlights the importance of the general assumption that coal prices will not track the ongoing and projected increases in oil prices. Developments on coal transportation rates, State severance taxes, and expanding environmental requirements, all bring this assumption into question. As discussed elsewhere in this paper, it is encumbent on Federal energy policy to assure excessive economic rents do not accrue to those who control indigenous energy resources that serve as the alternatives to imported oil.

Thus, oil usage in the utility sector should decline with increasing oil prices. Some reduction in utility oil consumption mentioned above is economical at current world oil prices. Even more will be economical, based on likely future world oil prices. However, there are several "institutional" factors which could inhibit or prevent this oil displacement. Such institutional barriers include:

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a/ Under assumptions of long-term constraints in gas supply natural gas freed up from use in utility boilers will, in turn, displace oil in the industrial, commercial and

utility management away from capital programs aimed at displacing oil.

- Inability to raise capital. Many utility companies, especially those with high levels of oil consumption, are in a financially weak condition. b/ For example, pre-tax interest coverages for the industry overall have have dropped from values of 4X in the late 1960s to only 2X currently. c/ In the same period, the ratios of market value to book value of utility stocks have dropped from in excess of 1.3 in the late 1960s to their current levels between .8 and 1.0. The oil-based utilities tend to have financial ratios which are considerably worse than the non-oil-based companies. This is generally a result of State regulatory authorities failing to increase electricity prices on a timely basis in conjunction with increases in production costs. Oil and gas based utilities have faced the most severe cost increases and as a result, are generally in worse financial condition than coal and nuclear based utilities. As a result of these financial problems, these utilities will not want to build generation plants beyond that needed to meet load growth - which does not allow for the displacement of oil consumption. There is some reason for concern that many utilities may not even be able to finance plants required to meet future loads. This proolem is concentrated in a few regions.

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b/ A more detailed exposition of the financial problems facing this industry is contained in a draft report completed by Booz-Allen & Hamilton, Inc. for DOE entitled "The Financial Health of the Electric Utility Sector, Implications to National Energy Policy, and The Role of the Oil Backout Bill".

capital costs reflected in electricity prices are highest in the first year and decline to zero at the end of the book life of the plant. As a result of this practice, a paradox exists: new facilities which will reduce electricity prices over the long run (i.e., the present value of the revenue requirements are lower if the new facilities are built) will cause electricity prices to go up in the early years. Because of these early-year price increases, public utility commissions may disapprove any capacity expansion that is not needed to meet demand growth, even though such expansion may make sense economically (the present value of electricity rates will be lower). Also, because utility commissions typically require that any capital investment included in the utility s rate base be used and useful, early retirement of oil-fired plants based on economics may be inhibited.

II. SHORT-TERM CONTINGENCY PLANNING

The electric utility industry offers somewhat limited opportunities for effective response to interruptions in oil supply. The generation infrastructure of the industry is not subject to quick modification. Fortunately, only about a third of the industry s fuel consumption is oil and gas (about equally split between the two fuels). However, the use of these fuels is concentrated in particular regions of the country (New England, Mid-Atlantic, Gulf Coast and California), so that supply interruptions can have severe impacts on some parts of the country without affecting other parts at all.

There is some limited opportunity for wheeling (intersystem exchange of electric power) of coal and hydro based power generation into oil and gas based regions. It is estimated that as much as 2-300,000 barrels/day of oil is being displaced by wheeling currently. Unfortunately, transmission limitations would preclude such wheeling schemes from being expanded more than about 10 to 20 percent to meet any short-term emergencies.

Both coal and nuclear power face uncertain futures as fuel sources for electric generation. This is especially true in geographic regions where these alternate fuels have not been used previously (e.g., New England, California, Florida and the Gulf coast). Policy focusing on oil and gas displacement must be coordinated with policy and program initiatives targeted at assuring the viability of alternative fuel-based technologies. These issues are covered in more detail in other chapters on nuclear, coal, solar, etc. It is important that the fuel mix of the industry independent of oil and gas displacement be optimized in terms of diversity and security of supply.

In conjunction with the issue of the vitality of the coal and nuclear options is the issue of lead times on new facilities. New coal and nuclear facilities have undergone severe extensions in the time required for siting, permitting and construction. For nuclear plants, estimates for the total timeline are as great as 15 years for new units to come into service. This creates a significant problem for utilities which recognize the pressing need to move off of oil and gas as quickly as possible, given the recent increases in world oil prices. It should be a fundamental objective of DOE to reduce these long lead times in what ever way possible while protecting other vital public interests.

The current uncertainties associated with nuclear power has potentiall ominous implications on oil and gas use in the 1980s. A two year delay in issuance on nuclear plant operating licenses could increase oil consumption in the industry by as much as 500,000 barrels/day.

B. INCREASED USE OF CONSERVATION AND LOAD MANAGEMENT

Pricing structures in the electric utility industry evolved during a period when electricity prices were falling in real terms. As a result, many pricing systems encourage increased consumption (declining block rate structures) and do not encourage off-peak use by not differentiating the price of electricity over time in association with its marginal cost of production. The Public Utilitie Regulatory Policies Act (PURPA) allows the Federal government to intervene in State rate proceedings to encourage maximum use of innovative rate structures, and load management programs to reduce the industries requirements of petroleum, natural gas and capital

Many utilities and State regulatory authorities have made aggressive efforts in recent years to promote rate innovation, conservation and load management. Through the vigorous enforcement of the PURPA goals and standards, these gains in rate policy can be expanded broadly throughout the industry. Additionally, through the National Energy Conservation Policy Act (NECPA) and other conservation legislation currently under consideration by Congress, new gains are likely in the next few years in energy conservation in the residential, commercial and industrial sectors.

C. DEVELOPMENT OF NEW TECHNOLOGIES THAT MEET NATIONAL OBJECTIVES OF REDUCED IMPORTS OR SERVE TO REDUCE POLLUTION EMISSIONS

Currently available technology will probably suffice in the industry' movement off of oil and gas. Conventional coal use has been the backbone of electricity generation for decades. With current and forecasted prices of oil and gas, the important objective in this case is not so much new technology development as it is the deployment of existing technology into areas that, due to past fuel economics, have not used it before.

To some extent, the same may be true of the environmental characteristics of new electricity generating technologies. Scrubbers and precipitators are developed to the point now that burning coal in a new facility is cleaner than burning oil in an existing facility New technology development by DOE to improve environmental characteristics of scrubbers and precipitators may offer only marginal benefit Advanced coal conversion technologies may offer substantial long term economic and environmental benefits. Deployment of early configurations of these technologies may be undertaken if these configurations can penetrate a sufficient portion of the utility sector to justify the costs of development and demonstration.

IV. GOVERNMENT PROGRAMS

A. LEGISLATION

The Administration plans to introduce, in early 1980, legislation targeted at reducing utility consumption of oil and gas by at least 33 percent (one million barrels/day). This target level of displacement was chosen on the basis of the economics of oil

are eventually converted, the total savings would be about 500,000 barrels per day. Phase II of the program focuses on oil and gas consumption in non-coal-capable plants. This phase would allow utilities to petition for Federal grants if they submitted plans that would yield reductions in oil and gas consumption by 1990. Such plans would be reviewed by State regulatory authorities to assure the feasibility and cost-effectiveness of the oil and gas displacement plan. Most important, such a program to displace oil would be surer, sooner, cheaper, and cleaner than many of the other programs (e.g., synfuels) being considered to reduce the U.S. dependence on foreign imported oil.

The program attacks the institutional barriers to oil and gas displacement indirectly. This approach is made necessary by the fact that regulation of this industry occurs at the State level. The Public Service Commissions that function as part of the State governments have the ultimate control over the financial viability of the utility companies and, therefore, control their ability to undertake the construction requirements imposed by the program. A Federal grant program of $12 billion (15% to 25% of total required investment due to program) is included to facilitate the financial requirements of the utilities; but even with these monies, State regulation will, in large part, determine whether program targets will be met.

The fate of this legislation will probably be determined by Congress in the first half of 1980. Future Administration activities on utility oil and gas consumption will, by necessity, be contingent on what legislation the Congress passes. If the legislation passes in its current form, additional legislative and policy initiatives may be appropriate which facilitate accomplishing the oil/gas displacement objectives. Such initiatives may be financial in nature (e.g., "Construction Work in Progress" CWIP in rate base) or logistical (attacking impediments to wheeling and power pooling) or technology related (e.g., synfuels development for boiler use).

- <u>Financial initiatives</u> - these would relate to the financial problems the industry faces in undertaking construction programs to displace oil. Issues such as inclusion of construction work in progress in the rate base, will need to be evaluated on a basis of whether the liquidity such accounting offers to utilities undertaking large construction programs is impo[illegible] to take on the political

struction. Another possibility is the development of return on equity standards which are targeted at assuring the financial viability of the industry.

- <u>Wheeling and power-pooling</u> - both of these offer opportunities for reduced oil consumption and lower electricity prices. Wheeling in the longer term is a potentially large oil displacing resource, but it is not clear that it will dominate solutions involving building new plants in proximity to the electricity demand, even in resource constrained areas such as California. Power-pooling to take advantage of the effectiveness of larger systems is an evolving process in the industry. The immediate task is to identify whether Federal legislation or regulation needs to deal more directly with encouraging more extensive pooling arrangements. These issues are currently under thorough examination in the national grid study being conducted by ERA and another analysis being conducted by FERC.

B. REGULATION

Both the Energy Supply and Environmental Coordination Act (ESECA) and the Fuel Use Act (FUA) provide a regulatory opportunity to convert certain utility powerplants from oil to coal.

Enforcement of these programs must be closely coordinated with the current legislative initiative. These programs offer earlier but smaller shifts from oil to coal in the utility sector than the President°s proposal.

Under PURPA, the Economic Regulatory Administration is allowed to intervene in the State regulatory process to encourage certain national energy objectives. The early implementation of this program has been focused to a great extent on marginal-cost and time-of-use pricing systems consistent with the goals and standards set our in PURPA.

A lesser focus has been on oil displacement, and no attention has been given to the financial ramifications of rate findings on utility companies and the ensuing consequences on oil and gas displacement, of future electricity supply and the adequacy. Expansion of this

with not displacing oil and gas. The intervention program could be an important vehicle in this regard. "Jawboning" tactics as this intervention program do not guarantee positive and timely moves by State regulatory authorities. It must be recognized that Federal authorities in this area are limited. Sometime, the implications of electric utility behavior may be of such national consequence that more regulatory control will need to be vested with Federal authorities, however, that time has not arrived. The success or failure of State regulation in moving the utilities off of oil and gas may be the determining factor in whether such shifts of authority are necessary.

construction.

The fiscal guidance is presented in three levels for each organization--a basic level, a decremented level, and an enhanced level. In developing these, the following programs were treated separately and guidance has been provided at the same level in all three cases. For uranium enrichment the Assistant Secretary for RA has the flexibility to develop a program at a level lower than that provided in the minimum case guidance.

- o Strategic Petroleum Reserve
- o Solvent Refined Coal Demonstration Plants (both Construction and Operations)
- o Uranium Enrichment Cost and Revenues and Uranium Resource Assessment

Fiscal guidance at the basic level contains the following for each organization.

- o Construction projects representing a continuation of those approved in the FY 1981 budget and prior years. Costing of these projects in the fiscal guidance is in accordance with the approved total estimated cost (TEC).
- o Capital equipment and operating dollars based on a continuation of approved programs in FY 1981 budget.
- o Salary for Federal employees based on the rates in the FY 1981 budget.

The three levels were constructed as follows:

- o The basic level guidance essentially represents a zero growth program overall and was computed using as proxy a continuation of the commitments outlined in the FY 1981 budget. In developing a balanced FY 82-86 program, however, the intent is not to constrain program organizations to reproduce the commitment projections at that level. New project starts can be programmed in FY 82-86 within each fiscal guidance level, and should include proper funding for capital equipment, construction and operating cost profiles in each year. This may require programmed reductions to the FY 81 commit-

level, and priorities must be shown if several items are p

Although manpower control levels have not been specified by year development of FY 82-86 programs, the base to be used is the numb full-time permanent positions identified in the FY 81 Congression Request. The total number of positions, identified at the progra level, cannot exceed these budget levels for either FY 80 or FY 8

Manpower requirements projected for FY 82 thru 86 will be develop on the minimum number of full-time permanent positions necessary achieve the programmatic goals and objectives consistent with the jected program funding levels. Manpower changes, therefore, will necessarily follow the percentage increments and decrements furni the dollar fiscal guidance. Funding and manpower projections for level should together represent a balanced estimate of resources to achieve specified program goals and objectives for each basic, and enhanced case in the out years.

....	\$ 2,462	\$ 2,805	\$ 2, 5	\$ 2,897	\$ 2,942	\$ 2,
....	1,037	1,236	1,249	1,182	1,221	1,
....	278	310	310	310	310	
....	1,683	1,544	1,647	1,638	1,566	1,
ess SRC) ...	755	766	800	800	800	
....	101	375	1,041	893	434	
tions:						
oleum						
....	---	2,404	2,191	4,274	6,000	6,
ment	315	123	553	282	374	
....	543	612	601	570	554	
olar						
....	1,482	1,794	1,941	1,978	1,696	1,
egulatory						
....	73	76	76	76	76	
tory						
....	192	154	115	100	87	
als	6	8	7	5	5	
ion						
....	108	116	116	116	116	
tion	16	20	20	20	20	
ffairs	4	5	4	3	2	
....	37	57	102	69	69	
....	-92	-66	-66	-66	-66	
Controller ..	264	292	292	292	292	
s	---	1	1	1	1	

...	1,037	1,236	1,311	1,304	1,414	1,
...	278	310	326	342	359	
...	1,683	1,544	1,729	1,807	1,813	1,
(less SRC) ...	755	766	840	882	926	
...	101	375	1,041	893	434	
ations:						
roleum						
...	---	2,404	2,191	4,274	6,000	6,
hment ...	315	123	553	282	374	
...	543	612	631	629	642	
Solar						
...	1,482	1,794	2,038	2,182	1,964	2,
Regulatory						
...	73	76	80	84	88	
tory						
n ...	192	154	121	110	101	
als ...	6	8	7	6	6	
ion						
n ...	108	116	122	128	134	
tion ...	16	20	21	22	23	
ffairs ...	4	5	4	3	2	
...	37	57	107	76	80	
...	-92	-66	-69	-73	-76	
Controller ...	264	292	307	322	338	
...	---	1	1	1	1	
al Affairs...	15	19	20	21	22	
...	2	3	3	3	3	

	1980	1981	1982	1983	1984	198
....	$ 2,462	$ 2,805	$ 2,572	$ 2,607	$ 2,648	$ 2,
....	1,037	1,236	1,124	1,064	1,099	1,
....	278	310	279	279	279	
....	1,683	1,544	1,482	1,474	1,409	1,
ess SRC) ...	755	766	720	720	720	
....	101	375	1,041	893	434	
tions:						
oleum						
....	---	2,404	2,191	4,274	6,000	6,
ment	315	123	553	282	374	
....	543	612	541	513	499	
olar						
....	1,482	1,794	1,747	1,780	1,526	1,5
egulatory						
....	73	76	68	68	68	
ory						
....	192	154	104	90	78	
ls	6	8	6	5	5	
on						
....	108	116	104	104	104	1
ion	16	20	18	18	18	
fairs	4	5	4	3	2	
....	37	57	92	62	62	
....	-92	-66	-59	-59	-59	-
ontroller ..	264	292	263	263	263	2

BASIC

	FY 81	FY 82	FY 83	FY 84	FY 85
	375	1,041	893	434	255
	2,404	2,191	4,274	6,000	6,000
Enrichment	123	553	282	374	287
	9,752	10,095	10,013	9,713	9,776
	$12,654	$13,880	$15,462	$16,521	$16,318

ENHANCED

	FY 81	FY 82	FY 83	FY 84	FY 85
	375	1,041	893	434	255
	2,404	2,191	4,274	6,000	6,000
Enrichment	123	553	282	374	287
	9,752	10,600	11,044	11,247	11,878
	$12,654	$14,385	$16,493	$18,055	$18,420

DECREMENTED

	FY 81	FY 82	FY 83	FY 84	FY 85
	375	1,041	893	434	255
	2,404	2,191	4,274	6,000	6,000
Enrichment	123	553	282	374	287
	9,752	9,086	9,012	8,742	8,798
	$12,654	$12,871	$14,461	$15,550	$15,340